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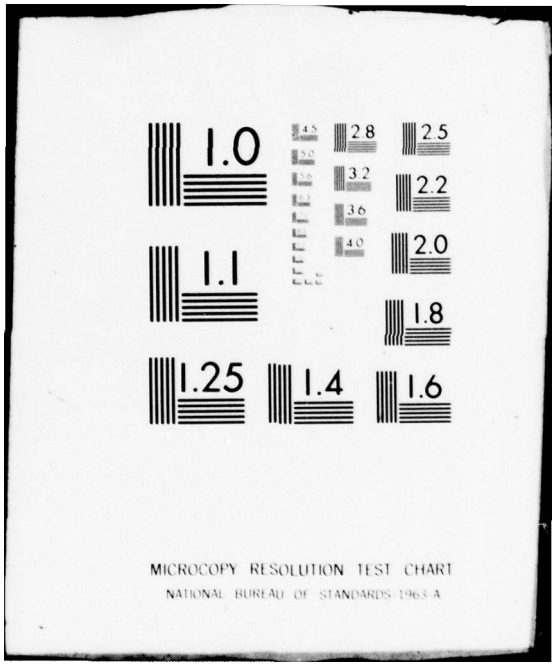
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SCHUYLKILL RIVER BASIN

ANTIETAM CREEK, BERKS COUNTY

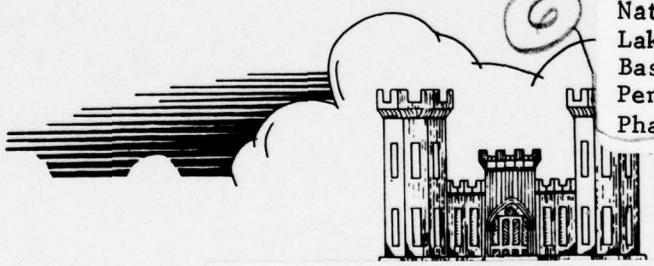
PENNSYLVANIA

ID NO. PA. 00716

Number

LAKE ANTIETAM DAM

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



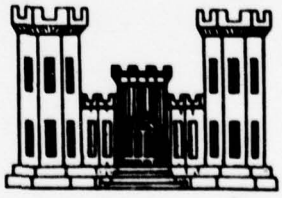
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

SEPTEMBER 1978

SCHUYLKILL RIVER BASIN

LAKE ANTIETAM DAM
BERKS COUNTY, PENNSYLVANIA
NATIONAL I.D. NO. PA 00716

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



Prepared by:

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Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

September 1978

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Lake Antietam Dam
County Located: Berks County
State Located: Pennsylvania
Stream: Stony Creek
Coordinates: Latitude 40° 21.3' Longitude 75° 52.2'
Date of Inspection: 28 August 1978

Lake Antietam Dam is a combined earth and masonry structure approximately 60 feet high and 230 feet long with a crest width of 17 feet. The dam is founded on rock and impounds a 16 acre reservoir within a 5.5 square mile drainage basin. The dam was built in 1880 with major reconstruction of the structure in 1914. The dam is assessed to be in fair condition.

Hydrologic and hydraulic computations presented in this report indicated that the dam will only pass 52 percent of the probable maximum flood (PMF) without overtopping. At this flow, overtopping would first occur adjacent to the abutments over both highways and down into the stream valley below. Based on the calculations and criteria discussed in Section 5 in Appendix C of this report, overtopping of the parapet walls is not expected. It is judged that the parapet walls could withstand the 2.5± feet of water that would be impounded against them during the PMF event. Since the spillway will overtop and the highways be flooded at flows greater than 0.52 PMF, the spillway is considered to be "Inadequate".

The dam is classified as an "Intermediate" size dam by virtue of its 60 foot height. The dam is also considered to be a "High" hazard structure because in the event of failure, there is a possibility of loss of life and extreme property damage downstream.

The following recommended remedial work should be undertaken immediately and is presented in order of priority. However, this does not infer that the latter recommendations are not important.

1. The wet zones at the base of the dam should be drained and organic materials removed. This regrading would drain the valve house and remove the water from around the valve control mechanism.

2. The valve should be cleaned, lubricated and restored to a operable condition.

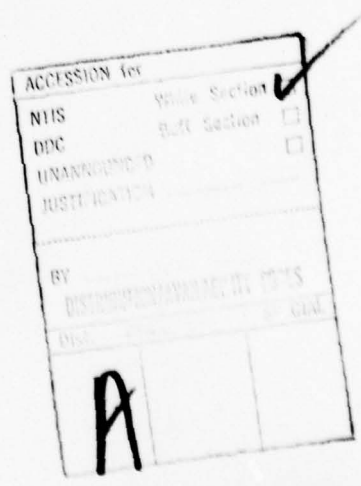
3. The spillway should be reassessed by a registered professional engineer and rehabilitated as necessary. This rehabilitation would most likely include restoration of the channel walls, realignment of the spillway crest and, possibly, anchorage of the spillway capstone.

4. Vegetation should be removed from the downstream face of the dam and the joints repacked to minimize deterioration. The galvanized drain pipes extending from the downstream face should be cleaned to insure that the seepage is relieved.

5. The base of the dam should be monitored for seepage and the flow rates and changes in turbidity checked periodically.

6. The stability of the dam should be reassessed using state-of-the-art criteria together with a seismic stability analyses. Stability analyses should take into consideration all of the noted deficiencies listed in Section 6 of this report.

Because of the location of the dam upstream from highly populated areas, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. The procedure should include a method of warning downstream residents and industries of potentially high flows. More details regarding these recommendations are discussed in Section 7, Paragraph 7.2b.



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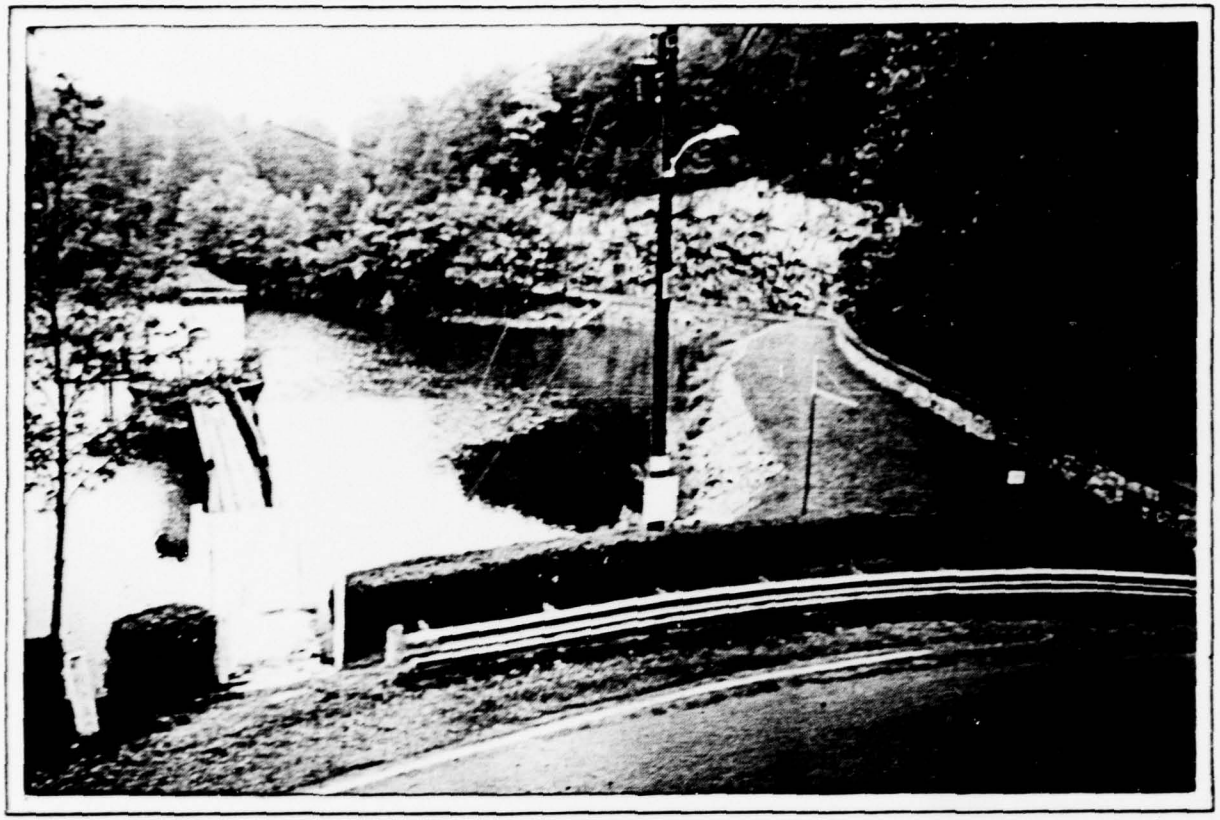
APPROVED BY:

28 Sep 78
Date

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer



OVERVIEW
LAKE ANTIETAM DAM, BERKS COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
LAKE ANTIETAM DAM
NATIONAL ID #PA 00716
DER #6-2

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lake Antietam Dam is a 60-foot high masonry structure with an upstream compacted fill embankment with an impervious core approximately 8 feet wide. The dam is approximately 230 feet long with a crest width of 17 feet. The embankment impounds a 16-acre reservoir within a 5.5 square mile drainage basin. The upstream slope is 2.25H:1V, and is riprapped from the crest to elevation 498 with hand-placed stone. The downstream slope is composed of stacked masonry block and has a curved surface, as shown on Plate 5, Appendix E. The dam was founded on trap rock, and does not have a cutoff trench or a grout curtain. There is a 4-foot high parapet wall along the downstream side of

CONT'

the crest. The spillway is excavated into solid rock on the left abutment, and has a skewed spillway with a crest width of 66 feet discharging into a channel which narrows to 30 feet at the end. Thereafter, water discharges into the natural streambed below the dam. The intake tower is located 125 feet upstream from the crest, and contains one discharge pipe, as shown on Plate 5. It is noted that this discharge pipe is no longer operational, and that the reservoir no longer serves as a water supply source. The dam contains a pond drain with a control valve at a valve house located at the downstream toe of the dam.

ADSTRACT

b. Location. Lake Antietam Dam is located across Antietam Creek, about 3.5 miles northeast of Reading, Pennsylvania, in Lower Alsace Township, Berks County, Pennsylvania. The dam site and reservoir are shown on USGS Quadrangle entitled, "Birdsboro, Pennsylvania", at coordinates N 40° 21.3' W 75° 52.2'. A regional location plan is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as "Intermediate" by virtue of its 60-foot height.

d. Hazard Classification. A "High" hazard classification is assigned consistent with the potential for extensive property damage and probable loss of life downstream to the residents along Antietam Creek.

e. Ownership. The dam is owned by the City of Reading. All correspondence should be sent to Mr. George C. Patton, Chief Engineer, City of Reading, 8th and Washington Streets, Reading, Pennsylvania 19601.

f. Purpose of Dam. The dam was originally built to supply water to the City of Reading. Currently, this dam is no longer used by the city and serves no purpose.

g. Design and Construction History. The sole source of the original design documentation is presented in a report entitled, "Report Upon the Investigation of

the Stony Creek[1] Dam of the Reading Water Department near Reading, Berks County, Pennsylvania", Report No. 138, dated 10 December 1913, and prepared by Mr. George F. Wieghardt, for the Water Supply Commission of Pennsylvania. The following information was extracted from that report.

The dam was designed by Mr. H. P. M. Birkinbine of Philadelphia, Pennsylvania, and constructed in 1880 by Mr. Christian Eben. The resident engineer in charge of construction was Mr. Levi Wunder.

As stated in the report, the dam was built with heavy trap rock stones. The interstices were filled with broken stone and layed in a matrix of cement mortar. The dam is arched upstream with a radius of 550 feet. The crest length is 230 feet with a crest width of 17 feet. The upstream face of the masonry wall has a slope of 1H:10V and the downstream face is curved, giving a 47 foot width 50 feet below the crest. The maximum height above the stream bed is 60 feet, and the width at the base of this section is 48 feet. This 48-foot section is limited to the masonry portion of the dam. The total width at this depth is approximately 160 feet. The original dam was placed with a puddle fill approximately 8 feet wide against the upstream face of the masonry portion of the dam. The batter of the fill was 4H:55V, and the thickness ranged from 4 to 8 feet. A 2-foot wide 4-foot high parapet wall was constructed along the downstream crest. Most of this information was reported to Mr. Wieghardt by Mr. H. Schildt, who worked on the dam during construction and was the dam's caretaker in 1913.

Included in this report is a stability analysis of the dam, in which the wave action and ice pressures were not considered. The results of this analysis indicate that the factors of safety against overturning ranged from 1.85 to 2.78. The resultants of these pressures reportedly fell within the middle third of all sections, indicative that the overturning factors of safety are reasonable.

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(1) Stony Creek is now known as Antietam Creek.

The spillway was excavated into solid rock at the eastern, or the left, abutment of the dam, but was rebuilt in 1914. Details of this reconstruction are described below.

As a result of the investigation performed in December 1913, it was recommended that the spillway be enlarged and reconstructed. It was recommended that the spillway be increased from its original 52-foot width to its present 66-foot width. This work began in 1914 under the direction of the City of Reading. The contractor for this work was Mr. William H. Dechant. The work was completed on 9 June 1915. A description of this reconstruction is presented as follows.

h. 1914 Reconstruction Activities. As a result of the 1913 investigation, the following deficiencies were presented by the State of Pennsylvania to the City of Reading.

"1. That the spillway is of insufficient carrying capacity;

"2. That the wasteway wall leaks and is not suitably secured to rock foundation;

"3. That the downstream face of the dam is moist from a line about 15 feet below the top, to the toe, and that at several places along the face, particularly noticable leaks appear at joints in the masonry, indicating the presence of interstices in the stone-work comprising the body of the dam, into which water, under pressure, finds its way;

"4. That the mortar in the joints of the masonry on the downstream face of the dam is disintegrating, and this face is overgrown with shrubs, weeds, moss and ferns, all of which tends to further disintegration from frost and roots;

"5. That the downstream leakage should be controlled."

The following summary of the work was extracted from four progress reports prepared by the State of Pennsylvania. Work began in early 1914, whereby the upstream face of the masonry portion of the dam was excavated and the upstream rock was cleaned. The cracks between the rock were carefully cleaned and filled with mortar. Thereafter, the entire upstream face was sprayed with at least one inch of gunite. The puddle backfill was replaced with hand-tamped silty clayey materials.

The downstream face of the dam was cleaned of vegetation and the joints between the masonry rocks were hand-cleaned and repacked with grout. Galvanized pipes, which were noted during the field inspection, were driven into the rock to relieve water pressure. The spillway and spillway retaining walls were removed completely and replaced. The foundations were excavated into rock. The spillway was increased from its previous 52-foot width to its present 66-foot width, its depth increased from five to six feet, and the spillway discharge channel enlarged to 30 feet wide at the discharge end.

The resident engineer for this work was Mr. John F. Witman, Jr., and the Chief Engineer was Mr. Emil Nuebling, both working for the City of Reading. The contractor for this work was William S. H. Dechant.

i. Normal Operating Procedures. Since the dam is no longer used, there is no official operating procedure. All water is discharged over the spillway located at the left abutment of the dam. The intake tower is reportedly never used and no longer functions. Although not shown on Plate No. 5, three gate valves were added to the outside of the intake tower, which are shown in a photograph dated 25 November 1914. It is not known the purpose these valves serve or what they are connected to. The dam contains a 30 inch diameter pond drain discharge pipe that discharges through the downstream toe. A valve is located at the toe and housed in a valve house. The dam contains a water level gauge manufactured by Bristol, Model 940M, Serial No. 477639, but the last known operation was in 1974. There are no records available as to water levels or discharges through the spillway.

1.3 Pertinent Data.

A summary of pertinent data for Lake Antietam Dam is presented as follows:

a.	Drainage Area (sq. miles)	5.5
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood at Site	Unknown
	Discharge at Top of Dam	3,300
c.	Elevation (feet above MSL)	
	Top of Dam	516.0
	Top of Parapet Wall	520.0
	Spillway Crest	510.0
	Control Tower Sluice Gates	All non-operable
d.	Reservoir (miles)	
	Length at Normal Pool	0.2
	Fetch at Normal Pool	0.2
e.	Storage (acre-feet)	
	Normal Pool	310
	Top of Dam	430
f.	Reservoir Surface (acres)	
	Normal Pool	16
g.	Dam Data	
	Type	Masonry structure with upstream earth embankment and central puddled core.

Length	230 feet
Height	60 feet
Crest Width	17 feet
Cutoff	None
Grout Curtain	None
Downstream Slope	Varies (see Plate 5).
Upstream Slope	2.25H:1V

h. Diversion — Unknown

i. Discharge

Intake Tower	
Inlets	Two 24-inch diameter inlets 11.5 feet and 23 feet from top of tower. One 30 inch reservoir drain inlet 37 feet from top of tower.
Comments	Water supply inlets no longer function. Pond drain valve at toe of dam functions.
Spillway	
Type	Concrete triangular broad crested weir.
Location	Left abutment
Crest Length	66 feet

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of engineering data is presented on the checklist attached as Appendix A. Principal documents containing data used for this report are as follows.

1. "Report Upon the Investigation of the Stony Creek* Dam of the Reading Water Department near Reading, Berks County, Pennsylvania", Report No. 138, dated 10 December 1913, prepared by George F. Wieghardt, Assistant Engineer.

2. "Report Upon the Application of the Bureau of Water of the City of Reading", dated 8 June 1914 and prepared by Mr. George F. Wieghardt, Assistant Engineer for the Water Supply Commission of Pennsylvania.

3. "Progress Report Upon the Stony Creek Dam of the Reading City Bureau of Water", Report No's. 23 A; 23 B; 23 C; 23 D; prepared by Mr. Seelye, Division Engineer.

4. Construction photos (53) dated 1914 covering most phases of the rehabilitation work.

5. Miscellaneous inspection reports prepared by the State of Pennsylvania from 1919 through 1970.

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* Stony Creek is now known as Antietam Creek.

6. Miscellaneous letters, correspondence, memos, drawings located in the Department of Environmental Resources (DER) main office in Harrisburg, Pennsylvania.

7. A series of drawings provided by the City of Reading to the inspection team. These drawings are presented in Appendix E of this report.

Documents regarding the design and construction are not in DER files, but Reference No. 1 above provided sufficient data to reconstruct the construction activities. Based on research of DER files and conversations with representatives of the City of Reading, it is concluded that any design data no longer exists.

b. Design Features. The principal design features are illustrated on the plan and cross-section plates enclosed in Appendix E as Plates 2 through 5. These plates were reproduced from drawings provided by the City of Reading. A description of the design features is described in Section 1 of this report.

2.2 Construction.

Data concerning construction history is very limited and is presented in Section 1.2.

2.3 Operational Data.

Operational records and other related data have never been recorded. The Chief Engineer for the City of Reading indicated that only 570,000 gallons of water was ever used from this reservoir to supplement Reading's water supply. Since that time (date unknown), the water has never been used, and the facilities of the intake tower are considered inoperable. The last known operation of the water level gauge was 1974, but the records could not be located.

2.4 Evaluation.

a. Availability. All information presented herein was extracted from the records located in the DER files in Harrisburg, Pennsylvania, or from conversations with the Owner's representative and data received from the Owner. Design and construction data could not be located other than that previously described.

b. Adequacy. The available data included in the State files and presented in this report is not considered adequate to evaluate the engineering aspects of this dam.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix B and are summarized and evaluated as follows. In general, the appearance of the facilities indicates that the overall condition is fair.

b. Dam. The horizontal and vertical alignment of the dam appears to be good. There is no evidence of displacement or settlement. The downstream face showed considerable deterioration of the masonry joints. In several locations the joints were open to a depth of approximately 12 inches. Due to the steepness of the downstream face, only the joints between the masonry blocks could be inspected. The downstream face was wet from a point approximately 15 to 20 feet below the top of the parapet wall, and small seeps were visible running through many of the joints. All seeps appeared to be clear.

The earth at the base of the dam face was soft and wet. Water was running on the ground surface on the east side. Careful examination indicated that most of the water could be attributed to surface runoff and to water coming from the downstream face of the dam. No significant underseepage was observed in several shallow hand-dug excavations. The lowest portion of the downstream face contained a pool of water which was noted during many previous inspections (as early as the 1930's).

The valve control house was also flooded with water, which will probably freeze the valves in the winter. Several portions of the downstream face of the dam were covered with vegetation, including ferns, vines, small trees and moss. The bottom several feet of the base was covered with dead leaves, twigs and other decomposing vegetable matter.

Throughout the downstream face, there were pipes protruding which were installed during the 1914 rehabilitation to reduce seepage pressures in the dam.

There were no indications noted along the crest of excessive settlement, misalignment, distortion or other features to indicate possible dam instability. The parapet wall was thoroughly inspected and found to be in relatively good condition. The upstream riprap was also observed to be in good condition. The slope contained several small scarps from previous slope sloughing. These scarps range from 1 to 4 feet in diameter with a depth not exceeding 1 foot. These same scarps were noted in photographs taken during the 1970 inspection by the State of Pennsylvania. Since that 1970 inspection, there has been no noticable increase or change in these areas. There were a few rodent holes noted on the upstream crest and near the crest on the upstream slope. These holes do not pose an immediate hazard to the structure, but should be filled.

c. Appurtenant Structures.

1. Spillway. The spillway is located between the left abutment of the dam and the existing highway. The masonry wall (left side) dividing the spillway channel and the county road to the east is of rubble masonry and constructed directly on rock. There was some local undercutting of the wall noted, and the general condition of the joints is poor.

The concrete cap is deteriorated at the south end, but vertical alignment is satisfactory. However, the horizontal alignment shows a distinct bow near the south end. It appears that the upper section of the wall is being gradually pushed in. No provision appears to have been made for drainage of the water from behind the wall.

The right spillway wall is also generally deteriorated between the masonry joints. However, the alignment is good both vertically and horizontally. The concrete cap is deteriorated and, at the left side, several masonry rubble stones have been eroded from the top of the wall. Vegetation

is growing on the downstream side with a few large trees, 8 inches in diameter, growing at the outside base of the wall.

The spillway consists of a rubble masonry wall topped with a granite capstone. Its total height is approximately 5 feet and the length is 66 feet. The upstream portion of the spillway contains a concrete apron. The downstream channel is cut into natural rock. The channel makes a 65° deflection to the south around the dam and necks down to 30 feet between the dam and the existing highway at the end of the spillway. The alignment of the spillway cap appears to bow downstream slightly. The vertical profile, however, looks very good. An open joint was observed between the cap and the upstream concrete apron. A detailed inspection of the spillway indicated that the base joint below the cap in the main masonry wall is fractured and deteriorated. At a few local spots the joint was open to a depth of approximately 4 inches. Also, the front edge of the cap protrudes beyond the face of the masonry wall. The supporting wall appears to be in good condition. It is judged that the cap was probably displaced due to high flows or possibly ice forces against the cap.

2. Outlet Works. As previously described, the principal water supply outlet works have not functioned for many years, and it is assumed that all valves are inoperable. The Owner's representative indicates that the pond drain located through the base of the dam, and controlled by a valve at the downstream toe, is operated twice per year. Records indicate that this valve requires two men to operate. This valve was not exercised during the inspection. The valve was coated with rust, the interior of the valve house leaks, and there is water up to the top of the pipe. It is believed that during the winter, ice could freeze this valve rendering it totally inoperable in the event that it is necessary to lower the reservoir.

d. Reservoir. Reconnaissance of the reservoir disclosed no evidence of significant siltation, slope instability or other features that would significantly affect the storage capacity of the reservoir. The side slopes are moderate to steep

and densely vegetated. There were several very small sloughed areas noted around the edge of the reservoir, but the volume was insignificant, being less than 10 cubic yards and averaging probably 4 to 6 cubic yards.

Some minor sedimentation was noted along the edge of the reservoir, and several small soil fans were noted at the mouths of streams. Vegetation is beginning to develop on these soil spits. However, the effect on flood storage capacity is assessed to be insignificant.

e. Downstream Channel. The downstream channel flows through a steep narrow valley for about 2,500 feet to the community of Stony Creek Mills. There are six houses between the dam and Stony Creek Mills, 18 to 24 homes subject to flooding during high flows and more subject to damage in the event of failure.

3.2 Evaluation.

In summary, the visual survey of the dam disclosed no evidence of existing instability of the structure. However, the seepage emanating through the downstream slope and the water accumulations at the toe of the dam are considered undesirable and should be evaluated. The pond drain should be rehabilitated to insure that it would operate in time of emergency. Recommended additional investigations and evaluations are presented in Section 7.

SECTION 4
OPERATION PROCEDURES

4.1 Procedures.

The caretaker, who lives on the hillside adjacent to the right abutment of the dam, operates the pond drain valve once or twice per year, and lubricates it as necessary. There are no formal written procedures describing the operation of this dam. The intake tower no longer functions, and it is assumed that all valves are inoperable.

4.2 Maintenance of the Dam. The dam is maintained by the caretaker who lives near the structure and the grass is periodically cut. There is no evidence to indicate that the downstream face is maintained or cleaned of vegetation.

4.3 Maintenance of Operating Facilities.

Since the intake tower no longer functions or serves as a water supply source, there is little maintenance performed to the tower or its contents. Other maintenance is limited to merely operating the pond drain valve once or twice per year.

4.4 Warning Systems in Effect.

There are no formal warning systems or procedures established to be followed during periods of exceedingly heavy rainfall. The dam is checked daily for unusual conditions. It is understood that the dam caretaker, who lives at the site, would notify local police and civil defense authorities in the event that an

emergency develops. However, it is noted that during Tropical Storm Agnes (June 1972) the caretaker was called downstream and the dam was left unattended.

4.5 Evaluation.

There are no written operational procedures, maintenance procedures or any type of warning system. If this dam is to continue to be controlled by the City of Reading, maintenance and operating procedures should be developed, which includes a checklist of items to be observed, operated and inspected on a regular basis.

Since a formal warning procedure does not exist, one should be developed and implemented during periods of extreme rainfall. This procedure should consist of a detailed method of notifying residents downstream that potentially high flows are imminent or a dangerous condition is developing.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design/Evaluation Data. No original data is available for the dam although comprehensive evaluation/redesign data is in the State files. As noted in Section 1, in 1914 the State directed the Owners to enlarge and increase the depth of the spillway.

The watershed is about 3.2 miles long and 1.9 miles wide with a total drainage area of 5.5 square miles. Elevations range from 1100 in the upper reaches to 510 feet at the normal pool elevation. There are two upstream dams on Antietam Creek. An unnamed dam is immediately above the reservoir and Hinnerskiz Settling Basin is about 0.6 miles above the reservoir. The unnamed dam is about 16 feet high with a 2.8 acre reservoir surface area. Hinnerskiz Settling Basin is 9 feet high with a 3 acre reservoir surface area. Both dams were constructed to trap sediment and are presently quite full. The available flood storage is very small and will have a negligible effect on the analysis of Lake Antietam Dam. The watershed is about 50 percent wooded with an estimated 10 percent residential development. It is expected that residential development will continue at a moderate rate.

The 1914 evaluation data of the redesign included an elevation-discharge table, an elevation-storage table and an inflow hydrograph for the storm of record, 5.48 inches of rain in two hours on 3 August 1898. The peak inflow rate was computed to be 3,271 cfs, and the maximum spillway capacity was computed to be 3,395 cfs with the reservoir level at the top of the dam.

In accordance with the criteria established by the Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard potential classification, is the probable maximum flood (PMF).

b. Experience Data. No reservoir water level records or rainfall records are maintained. No estimate was available of the depth of flow over the spillway during Tropical Storm Agnes, June 1972, frequently the storm of record for this part of the State.

c. Visual Observations. On the date of the inspection there were no conditions observed that would indicate that the outlet capacity would be reduced during a flood occurrence. It is noted that the upstream Hinnerskiz Settling Basin is in poor condition and the spillway is deteriorated. Observations regarding the condition of the downstream channel, spillway conditions, and reservoir are located in Appendix B.

d. Overtopping Potential. The redesign data was evaluated, as shown in Appendix C. The maximum spillway capacity is 3,300 cfs with the reservoir surface level at the top of the embankment and with the downstream channel constriction as the hydraulic control section. The peak PMF inflow rate is estimated to be 6,600 cfs, as determined from doubling the Standard Project Flood (generally 40 to 60 percent of the PMF event), from "Flood Plain Information, Antietam Creek and Heisters Creek, Berks County, Pennsylvania", prepared by the Corps of Engineers, Philadelphia District. The publication also states that the outflow from Antietam Dam is essentially the inflow because of the very limited available flood storage. This is supported by calculations in Appendix C. The maximum discharge of 3,300 cfs is capable of safely discharging an inflow of about 3,400 cfs and the required discharge to pass the peak PMF inflow is about 6,400 cfs, nearly the estimated 6,600 cfs inflow. Therefore, the spillway is capable of discharging about 52 percent of the PMF. The embankment will overtop during a PMF event by approximately 3.3 feet. If the embankment overtops, water will flow around the dam and down the roadways on the right side of the dam and down the roadway on the left side of the spillway. As each road is excavated in rock and protected by asphalt, discharge down the roads will not lead to immediate failure of the dam. The parapet wall is 4 feet high and judged capable of withstanding the estimated 3.3± feet of water that would overtop the crest and be stored behind the wall.

e. Spillway Adequacy. The spillway system is rated as "Inadequate" as the embankment will overtop during a PMF event, but the spillway is not "Seriously Inadequate" as it will discharge more than 0.5 PMF without overtopping the embankment. The tailwater elevation will be controlled by the downstream culvert for large discharges from the dam. The tailwater is estimated to be 20 feet below the crest of the dam for the maximum computed spillway discharge.

f. Downstream Conditions. For 2,500 feet below the dam, the stream flows through a steep narrow valley to the community of Stony Creek Mills. There are six houses in the first 2,000 feet below the dam. In Stony Creek Mills there are another 18 to 24 homes subject to flooding during high flows, and more are subject to damage in the event of failure. Therefore, the "High" hazard potential classification is justified.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The visual observations did not indicate any existing embankment stability problems. However, the downstream toe of the slope is marshy with ponded water and seeps were noted through the rock on the downstream face. There are no indications of misalignment, settlement or unusual distortions of the dam, either on the downstream face or the crest. The upstream face contained a few small scarps which are discussed in Section 3.1.

The emergency spillway was assessed to be in fair condition. Deterioration was noted along the rock joints and the mortared riprapped walls. Distortion of the spillway crest cap was also observed. It is assessed that this cap distortion is probably associated with ice forces or high flows over the spillway. Some minor distortions were observed along the rubble walls which are not judged to be signs of imminent instability. These walls should be reassessed and repaired as necessary, together with the spillway cap.

As previously described, the intake tower no longer functions and serves no purpose. Since the pond drain is buried beneath the embankment, it could not be inspected. However, the valve control mechanism at the downstream toe was inspected and assessed to be in poor condition. The valve is coated with rust, and the valve house is flooded, covering a good portion of the pipe. During the winter, it is likely that the water would freeze and the ice would prevent the valve from operating in the event that it is necessary to draw down the reservoir.

b. Design and Construction Data. A review of available records and discussions with the Owner's representative leads to the conclusion that there is probably no original design data available. All data concerning physical features of

the dam were determined by post-construction investigations performed in 1913. Based on this data and the visual inspection performed on 28 August 1978, it is judged that there is not adequate data to thoroughly evaluate the dam.

Data in DER files included a stability anlaysis performed in 1913. A review of this analysis indicates that at the time of the investigation, this analysis represented state-of-the-art techniques. However, today, this analysis fails to consider several of the following items:

1. The increase in soil pressure due to the submerged weight of the earth compacted against the upstream face of the structure.

2. The effects of ice loading, which was reported to be in excess of 20 inches in 1977.

3. A more realistic approach in establishing the true uplift along the base of the dam, instead of the arbitrary 2/3 head used during that analysis.

c. Operating Procedures. There are no procedures established to operate this facility.

d. Post-Construction Changes. The major post-construction change noted in the records was the work performed in 1914, which consisted of resealing the upstream face of the masonry portion of the dam, enlarging the spillway, and installation of weep holes on the downstream face, together with repointing the downstream rock. Since that date there have been no changes made to the dam or reservoir.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considerd that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. Since the static factor of safety for this dam using current state-of-the-art techniques is unknown, a seismic stability evaluation could not be made. It is also noted that this dam

contains a mortar gravity section as well as an earth section. Therefore, the assumptions used by the Corps of Engineers to assess dynamic stability based on static stability evaluations may not be valid for this type of embankment configuration.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. The visual inspection indicates that the dam is in fair condition. The ponded water at the downstream toe of the dam, the seepage noted through the joints in the downstream face and the wet marshy areas along the toe of the dam are considered undesirable and should be remedied. A description of the recommended measures is described in Section 7.2. The minor sloughs on the upstream slope have apparently remained unchanged since at least 1970, and are considered to be minor in nature. The three rodent holes noted along the crest of the dam, although not considered to be critical, should be filled.

The emergency spillway is considered to be in fair condition, with some wall dislocation and movement along the spillway channel. These wall movements, although not considered to be indicative of a potentially unstable condition, are undesirable and should be evaluated and repaired as necessary. The spillway cap has apparently been affected by ice or water forces and has been dislocated downstream somewhat. This should be evaluated and repaired, as described in Section 7.2.

The pond drain valve was inspected and assessed to be in poor condition. The base of the valve house is flooded with water to the doorsill, covering about one half of the pipe. In the winter, this water could freeze, rendering the system inoperable. The gear mechanisms are rusted and the system does not appear to be very well maintained.

The hydrologic and hydraulic computations presented in Appendix C indicate that the dam will not pass the probable maximum flood, but does pass approximately 52 percent of the probable maximum flood without overtopping the embankment. Therefore, the spillway system of this structure is considered to be

"Inadequate", but not "Seriously Inadequate". In the event that the outflow is greater than the spillway capacity, excess flow would discharge along the highway on each abutment of the dam. Considering that highways are founded in rock and asphalt paved, failure of the embankment is highly unlikely. Erosion along the emergency spillway and along the right abutment of the embankment of the dam is expected, but is not expected to lead to catastrophic failure. In the event of dam failure, significant property damage is expected along Antietam Creek, and the possibility of loss of life to the residents of the homes along the creek is likely. Therefore, the structure is considered a "High" hazard dam.

b. Adequacy of Information. Although details of the outlet works are unknown, this information is not considered essential in that the system no longer functions. A review of the available files indicates that there is no engineering design data associated with the original structure. There are no documents delineating the engineering properties of the materials used to reconstruct the core of the dam. Although a stability analysis was performed, it is noted in Section 7 that there were several deficiencies in this analysis when compared to current standards. There was sufficient documentation including a considerable number of photographs describing the rehabilitation work. However, the structural stability analysis, as performed in 1913, is not adequate according to current state-of-the-art procedures.

c. Urgency. The recommendations presented in Section 7.2 should be implemented as soon as practical.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following measures be undertaken. These recommendations are presented in order of priority, but does not infer that the latter recommendations are not important.

1. The wet area at the base of the dam should be drained and organic vegetation removed. This regrading would drain the valve house and remove the water from around the valve mechanism.

2. The valve should be cleaned, lubricated and restored to an operable condition so that is functions properly in the event of an emergency.

3. The spillway stability should be reassessed by a registered professional engineer and rehabilitated in accordance with the engineer's recommendations. This rehabilitation would include restoration of the channel walls and realignment of the spillway crest and possibly anchorage of the spillway capstone.

4. Vegetation should be removed from the downstream face of the dam and the joints repacked to minimize further deterioration. Organic materials and other debris and waste matter along the downstream toe should be removed and the area regraded. The seepage should be monitored for changes in flow rates and turbidity.

5. The galvanized pipes, which are protruding from the downstream face, were noted to be dry and nonfunctioning. These pipes should be reamed clean in order to relieve seepage pressures.

6. The static and seismic stability of the dam should be reassessed using state-of-the-art criteria. The stability analysis should take into consideration all of the noted deficiencies listed in Section 6 of this report.

b. Operation and Maintenance Procedures. Because of the location of the dam upstream from highly populated areas, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This means that the caretaker should not leave the site as was done during the flood caused by Tropical Storm Agnes (June 1972). The warning procedure should include a method of warning downstream residents and industries. During a large storm,

when the outflow is greater than the spillway capacity, the highway on both sides of the dam would most likely be flooded, rendering access to the dam from lower elevations impossible. Therefore, it is recommended that the caretaker remain on site during periods of high precipitation to monitor the dam.

Since the dam no longer functions as a water supply source, there is no need to have an operational procedure for the intake tower control mechanisms. However, an operational procedure and regular maintenance procedure should be written for the pond drain system.

APPENDIX

A

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Lake Antietam Dam*

ID # *PA 00716*

ITEM	REMARKS
AS-BUILT DRAWINGS	*None available. The only drawings available are those located in Appendix E of this report.*
REGIONAL VICINITY MAP	*See Plate 1 of Appendix E.*
CONSTRUCTION HISTORY	*The "Report Upon the Investigation of the Lake Antietam Dam" was the only document describing construction of the dam.*
TYPICAL SECTIONS OF DAM	*See Appendix E for available drawings.*
OUTLETS - PLAN	*The only drawings available are those located in Appendix E of this report.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*Discharge capacity stated as 3395 cfs (1932 report).*
RAINFALL/RESERVOIR RECORDS	*None*

ITEM	REMARKS
DESIGN REPORTS	*No original design reports. The first documentation in DER files begins in 1914.*
GEOLOGY REPORTS	*None. See Appendix F for description and geologic map.*
DESIGN COMPUTATIONS	*Structural analyses contained in DER files.*
HYDROLOGY & HYDRAULICS	*No data available in DER files.*
DAM STABILITY	*A stability analyses was located in DER files.*
SEEPAGE STUDIES	*None available, only visual inspections reports.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*No original (1880) data available but there are several but very limited records of the 1914 spillway reconstruction work.*
POST-CONSTRUCTION SURVEYS OF DAM	*Yes. See Item 1 on page 4. Repair documentation in DER files contained several concrete test results (November 1914) and several letters stating that repair work was done very well.*
BORROW SOURCES	*No data available.*

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	1. Spillway reconstructed in 1914. Also, 30 inch blowoff pipe was repaired. During reconstruction the gunite was tested and found to be "quite satisfactory". 2. Downstream face repaired in 1965. 3. Several drawdowns were performed to remove silt.
HIGH POOL RECORDS	None available.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	See 1914 "Report Upon the Investigation".
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	During a 1902 rainfall, the spillway could not handle the flow and the roadway was washed out. As a result, the spillway was approximately doubled in size in 1914.
MAINTENANCE OPERATION RECORDS	None available.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E for available platee.*
	Spillway Elevation = 497.7 (1913 Survey)
OPERATING EQUIPMENT PLANS & DETAILS	*Very little data found in DER files.*
MISCELLANEOUS	1. *"Report Upon the Investigation of the Stony Creek Dam of the Reading Water Department", Report No. 138. 10 December 1913, by George C Wieghardt.* 2. *"Contract and Specification for Repair and Reconstruction of Antietam Dam".* 3. *"Report Upon Repairs and Reconstruction of Antietam Dam" May 28, 1914.* 4. *Inspection Reports from 1924 to 1970.* 5. *"Progress Report Upon the Stony Creek Dam" Report 23-D dated 3 December 1914, by Henry Birkenbine.* 6. *Same as No. 5-Report 23-B, 11 September 1914.* 7. *Same as No. 5-Report 23-A, 24 August 1914.* 8. *Same as No. 5-Report 23-C, 23 September 1914.* 9. *"Report Upon the Application of the City of Reading" Report No. 23, June 8, 1914.* 10. *Six B&W photographs- 1959.* 11. *52 B&W construction photographs (1914).*

APPENDIX

B

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Lake Antietam Reservoir* County *Berks* State *Pennsylvania* National ID # *PA 00619*

Type of Dam *Masonry with Earth Core* Hazard Category *I (High)*

Date(s) Inspection *28 Aug. 1978* Weather *Cloudy, Humid* Temperature *70's*

Pool Elevation at Time of Inspection *510.2* M.S.L. Tailwater at Time of Inspection *N/A* M.S.L.

Inspection Personnel:

Vince McKeever (Hydrologist) *Robert Griffith (Structural)* *John H. Frederick (Geotechnical)*

Mary Beck (Hydrologist) *John Boschuk, Jr. (Geotechnical/Civil)*

Ray Lambert (Geologist)

John Boschuk, Jr. Recorder

Remarks:

Mr. Ken Goodmiller-General Accounting Office *Mr. George C. Patton - Chief Engineer* } for City of Reading.

Mr. Andy Finkle-General Accounting Office *Mr. Howard B. Koch - Chief Engineer* }

Mr. John Sweesey - Caretaker

CONCRETE/MASONRY DAMS
MASONRY WITH EARTH FILL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*The downstream toe (low point) contains a pool of standing water and the downstream face of the dam is wet. There were no streams of seepage noted. The entire toe length is wet and organic. Most of the water is coming from the dam face and rainfall runoff.*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*Good condition.*	
DRAINS	*None observed other than galvanized pipes driven into the downstream slope face. These pipes were dry.*	
WATER PASSAGES	*N/A*	
FOUNDATION	*Could not inspect but records indicate that the entire dam was founded on rock.*	

CONCRETE/MASONRY DAMS

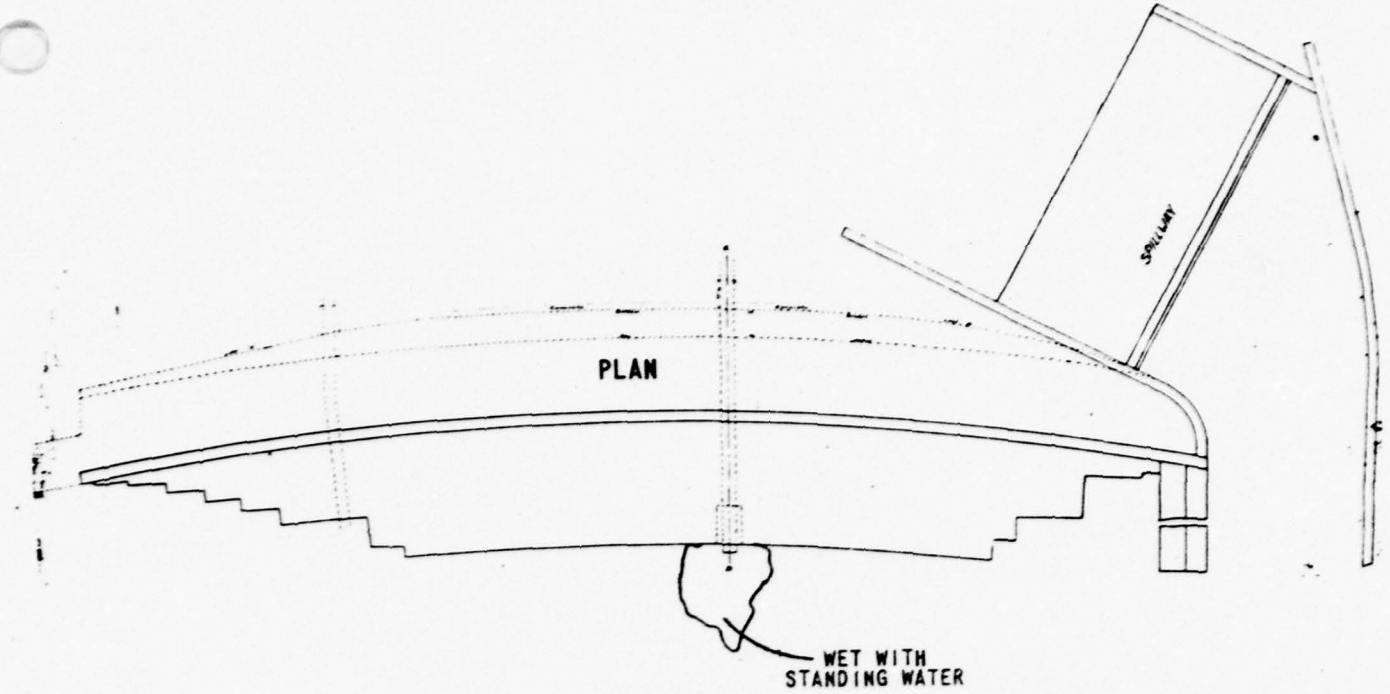
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*None observed. However, the mortar between the stones in the dam is deteriorated and vegetation has established in the cracks.*	
STRUCTURAL CRACKING	*None observed. The downstream face showed considerable deterioration of the masonry joints. In several locations, joints were open to a 12"± depth. The downstream face from a point about 15 to 20 feet below the top of the parapet wall was wet. Seeps were visible running from many joints. The seeps generally appeared clear. The earth at the base of the downstream face was very soft and wet. Water was running on the ground surface on the east side. This face contains vegetaion. The botton of the face is covered with dead leaves, twigs and other decomposing vegetable matter.*	
VERTICAL AND HORIZONTAL ALIGNMENT	*The dam has a curved upstream arch and the alignment looks very good.*	
MONOLITH JOINTS	*None*	
CONSTRUCTION JOINTS	*None. Hand place rock chocked with small stone, sand and grout.*	

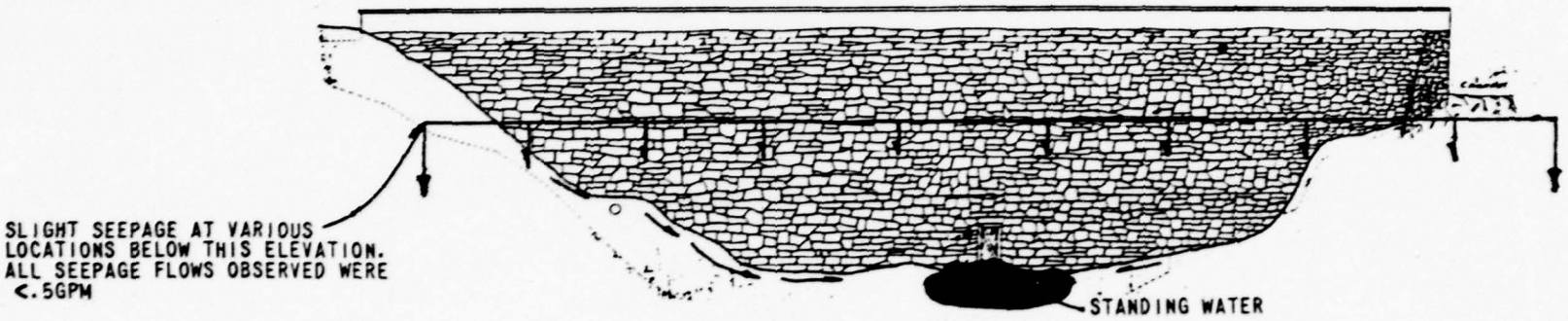
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed on central portion along crest but three animal holes were noted in the crest above the pool elevation.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*There was no sloughing in the main slopes which are constructed of hand placed rock. The central portion of the dam along the crest contains a raised earthen section. The downstream side has a 4 foot high parapet wall. The upstream side slopes down into the reservoir. A couple of small surface scarps were noted which appear to be very old and stable.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*Dam curves upstream. There are no unusual discontinuities in the curve.*	
RIPRAP FAILURES	*None observed and no records in files about any past failures.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*N/A*	
ANY NOTICEABLE SEEPAGE	*See page 2 of 11.*	
STAFF GAGE AND RECORDER	*Yes. Bristol recording gage in tower but it has not been in operation since 1974. Model 940m, Serial Number 477639.*	
DRAINS	*None known.*	





PROFILE

SEEPAGE LOCATION PLAN
LAKE ANTIETAM DAM

SHEET 5a OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*Conduit is buried and could not be inspected.*	
INTAKE STRUCTURE	*The main structure is in good condition but the valves are inoperable (as stated by the Chief Engineer).*	
OUTLET STRUCTURE	*The water supply outlet pipe (24" diameter) is connected to the tower. The gate is closed and the system is inoperable.*	
OUTLET CHANNEL	*The outlet works channel discharges directly into the spillway channel. The channel is stable, rocky and in good condition. There is some debris in the channel including trees up to 15 feet long which could float downstream and block the conduit.*	
EMERGENCY GATE	*The 30 inch pond drain is located at the base of the dam and is controlled by a gate valve at the downstream base. The Owner reports that the gate is opened once per year and lubricated. It does not appear to have been lubricated for many years. The entire valve is rusted and partially covered with water. The valve pit at the center base of the downstream face was full of water up to the level of the door sill. The parge coating on the walls was completely deteriorated and falling off. Considerable deposits of what appears to be $CaCO_3$ on walls. Water leaking through walls and into pit.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*Granite cap on mortar wall (66 feet long) serves as a spillway. Side walls are six feet. Cap is in good condition but some displacement was noted between the cap and the wall. The movement is downstream and most likely caused by ice forces. A more detailed inspection of the spillway indicated that the base joint below the cap and the main mansonry wall is fractured and deteriorated. In a few local spots the joint was open to a depth of 4"±. Also, the front edge of the cap protrudes beyond the face of the masonry wall below. The supporting wall appears to be in good condition.*	
APPROACH CHANNEL	*No approach channel.*	
DISCHARGE CHANNEL AND WALLS	*The masonry wall dividing the spillway channel and the county road to the east is of rubble masonry, built directly on the bedrock forming the base of the spillway channel. There is some local undercutting of the wall and the general condition of the joints is poor. The concrete cap is deteriorated at the south end. The vertical alignment is satisfactory, but the horizontal alignment shows a distinct bow near the south end. It appears that the upper section of the wall is being gradually pushed in. No provision appears to have been made for drainage of water from behind the wall. The western spillway wall also has general degradation of the masonry joints. The alignment, both horizontal and vertical, looks good. The concrete/mortar cap is deteriorated and, at the south end, several masonry rubble stones have been eroded from the top of the wall. Vegetation is growing on the rear side with a few large trees (8"diameter) growing right at the outside base of the wall.*	
BRIDGE AND PIERS	*None*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*Side slopes are moderate to steep and densely vegetated. Several sloughed zones were observed around the edge but the volume is insignificant being less than ten cubic yards and averaging four to six cubic yards.*	
SEDIMENTATION	*Sedimentation was noted along the edge of the reservoir and several small soil fans were noted at the mouth of streams. Vegetation is beginning to develop. However, the effect on flood storage capacity is insignificant.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*A new road has been built about 400 feet downstream of the dam. The total height of the embankment is about 40 feet. The road will control the tail-water elevation immediately below the dam.*	
SLOPES	*The valley gradient is about eight percent for 300 feet below the dam and then becomes about two percent. The valley is narrow with steep (up to 30 percent) side slopes.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*There are six houses in the 2000 feet below the dam. Then the stream passes through the community of Stony Creek Mills, where there are another 18 to 24 homes subject to flooding during high flows and more subject to damage in the event of failure.*	

APPENDIX

C

LAKE ANTIETAM DAM

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 50% wooded with about 10% residential development.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 510 (310 Acre-Feet).

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 516 (430 Acre-Feet)

ELEVATION MAXIMUM DESIGN POOL: ---

ELEVATION TOP DAM: 516

SPILLWAY

a. Elevation 510

b. Type Triangular broad crested weir.

c. Width 66 feet

d. Length ---

e. Location Spillover Left abutment.

f. Number and Type of Gates None

OUTLET WORKS:

a. Type Non-operable

b. Location At upstream toe.

c. Entrance inverts ---

d. Exit inverts ----

e. Emergency draindown facilities 30 inch pipe through base of dam.

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 3800 cfs. - channel capacity about 500 feet downstream.

DAM SAFETY ANALYSIS
HYDROLOGIC/HYDRAULIC DATA

Date: 9/12/78
By: MFB
Sheet: 2 of 12

DAM Lake Antietam Dam Nat. ID No. PA00716 DER No. 6-2

	ITEM/UNITS	Permit/Design Files (A)	Calc. from Files/Other (B)	Calc. from Observations (C)
1.	Min. Crest Elev., ft.	516.0		
2.	Top of Parapet Wall	520.0		
3.	Spillway[1] Crest Elev, ft.	510.0		
3a.	Secondary[2] Crest Elev, ft.	-		
4.	Max. Pool Elev., ft.			
5.	Max. Outflow[3], cfs	3395		
6.	Drainage Area, mi^2	5.08	5.5	5.54
7.	Max. Inflow[4], cfs	3271		
8.	Reservoir Surf. Area, Acre	29.0		16
9.	Flood Storage[5], Acre-Feet	187.0		
10.	Inflow Volume, ft^3			

Reference all figures by number or calculation on attached sheets:

Example: 3A - Drawing No. xxx by J. Doe, Engr., in State File No. yyyy.

NOTES:

(1) Main emergency spillway.

(2) Secondary ungated spillway.

(3) At maximum pool, with freeboard, ungated spillways only.

(4) For columns B, C, use PMF.

(5) Between lowest ungated spillway and maximum pool.

Date: 9/12/78
By: MEB
Sheet: 3 of 12

HYDROLOGIC/HYDRAULIC CALCULATIONS (cont.)

Item (from Sheet 2)	Source
1A, 2A, 3A, 5A, 6A, 7A 8A, 9A	Report upon Repairs & Reconstruction of Antietam Dam, dated May 28, 1914
6B	Flood Plain Information Book by Corps of Engineers, Phila. District
6C, 8C	USGS Maps Birdsboro, Pa (1968) Fleetwood, Pa (1969) Temple, Pa (1968) Reading, Pa (1968)

Classification (Ref. Recommended Guidelines for Safety Inspection of Dams)

1. The hazard potential is rated as "High." as there would be loss of life if the dam failed.
2. The size classification is "Intermediate" based on its 60-foot height.
3. The spillway design flood, based on size and hazard classification, is the probable maximum flood (PMF).

Hydrologic and Hydraulic Analysis

1. Original redesign information

   Spillway Capacity - see sheet 10

   Flood Storage Capacity - information not acceptable, see below

   Design Storm - storm of record, 3 Aug 1898, 5.48 inches of rain in 2 hours, peak inflow rate 3,211 cfs

2. Evaluation of information

   Spillway Capacity - calculations adequate. (Qo) (assuming no effect from d/s channel, see sheet 5)

   Flood Storage Capacity - reservoir surface area from current USGS Map is 16 acres, much less than 29 acres indicated in 1914 report. In determining flood storage, use reservoir area of 20 acres to account for flat slopes at upper end of reservoir.

   Design Storm - is the PMF storm

   PMP = 26.5 inches in 6 hours > 5.48 inch in 2 hours (Ref. TP-40)

Volume of inflow, V_I, assume 90% runoff

$$V_I = \frac{0.9 \cdot 25.5}{12} \cdot 5.5 \cdot 640 = 6732 \text{ Ac-Ft.}$$

Peak Inflow - Q_I

Information received from Corps of Engineers, Balt. District, indicates an estimated peak inflow = 2 x Standard Project Flood from "Flood Plain Information, Antietam Creek and Heisters Creek, Berks County, Penna." by Corps of Engineers, Phila. District.

SPF = 3300 cfs ∴ PMF = 6600 cfs

"Flood Plain Information..." states that outflow from Antietam Dam is essentially the inflow because of the very limited available flood storage.

Spillway Capacity considering downstream channel constriction

The constriction - rectangular, bottom width 31 ft at elev. 502

Conservatively assume critical depth, d_c, at constriction. Determine reservoir water surface for Q_o = 3300 cfs or 0.5 PMF (assuming no flood storage)

$$d_c = \sqrt[3]{q^2/g} = [(3300/31)^2/32.2]^{1/3}$$

$= 7.1$ ft

at critical depth, velocity head, $H_v = \frac{1}{2} d_c$

H_e, specific energy head $= d + \frac{V^2}{2g} = 10.6$ ft

Total energy head = elev + H_e = H_T

502 + 10.6 = 512.6 ft.

Assume no friction losses between weir and constriction such H_T below weir = H_T at constrict.

Elevation below weir ~ 504. ∴ $H_e = H_T$ - elev

$H_e = 8.6$ ft

Assume depth below weir is 8 ft.

Then $H_v = \frac{Q^2}{a^2 2g} = \left(\frac{3300}{66 \cdot 8}\right)^2 \div 64.4 = 0.6$ ft.

$H_e = 8 + 0.6 \equiv 8.6$ from sheet 5,
therefore $d = 8$ ft and weir
tailwater = 504 + 8 = 512 ft

If reservoir level is at 516 ft & tailwater elev. is 512 ft, submergence of weir has no effect - Ref. National Engineering Handbook, Section 11, p. 3.17

Consider effective weir length to be

$L = 66 - 0.2 \cdot 2 \cdot H_e$ eq. 4, Design of Small Dams, 2nd ed.

$Q = 3.5 (66 - 2.4) 6^{3/2}$
$= 3271 \sim 3300$ cfs

Therefore, with reservoir water level at the embankment level, $Q_D = 3300$ cfs which is equal to the estimated peak 0.5 PMF inflow

Percent PMF passed without overtopping embankment
Available storage, V_S = 20 x 6 = 120 Ac-Ft
Required storage, V_R, see sheets 10 & 11

$$V_R = \left(1 - \frac{Q_D}{Q_I}\right) V_I$$

for $V_R = V_S = 120$ Ac-Ft

$$120 = \left(1 - \frac{3300}{\chi 6600}\right) \chi 6732$$

$\chi = 0.52$

Therefore, 0.52 PMF does not overtop embankment.

Determine Reservoir Water Surface Elev. During PMF

Assume Reservoir Level @ 519.5

$V_S = 190$ Ac-Ft

$V_R = V_S = 190 = (1 - \frac{Q_o}{2600}) 6732$

$Q_o \simeq 6400$ cfs

When embankment overtops, water will flow down the roadway to the right of the dam and down the roadway to the left of the spillway. Assume each road 25 ft. wide

Right roadway entrance elev. at 516. Assume flow down road supercritical

$H = 3.5$ ft $d_c = \frac{2}{3} \cdot 3.5 = 2.333$ ft.

$\frac{V^2}{2g} = \frac{1}{2} d_c$; $v_c = 8.66$ fps $Q = a v \simeq 500$ cfs

Left road entrance elev about 518

$H = 2$ ft $d_c = 1.67$ ft $\frac{v_c^2}{2g} = \frac{1}{2} d_c = 0.83$ ft

$v_c = 7.33$ ft/sec $Q = 25 \cdot 1.67 \cdot 2.33 \simeq 300$ cfs

Required discharge over spillway = 6400 - 800 = 5600 cfs

At channel constriction

$d_c = \sqrt[3]{\left(\frac{5200}{31}\right)^2 / g} = 10.0$ ft

$V_c^2/2g = 5$ ft;

$H_T = d_c + H_v + \text{elev} = 517$ ft.

At section below weir, $H_e = 517 - 504 = 13$ ft.

assume $d = 12.2$ ft. $v = \frac{5600}{66 \cdot 12.2} = 6.95$ ft/sec

$H_v = 0.75$ $H_e = H_v + d = 12.95 \sim 13$ ft

Therefore, depth of tailwater = 12.2 ft.

Effect of submerged weir

Ref - National Engineering Handbook, Sect. 11, p. 3.16

H_2 = height of tail water over weir = 6.2

H_1 = height of reservoir water level over weir = 9.5

$H_2/H_1 = 0.65$; therefore $R = \frac{Q_s}{Q_f} = 0.92$

where Q_s = submerged discharge = 5600
Q_f = free discharge

$\therefore Q_f = 6086$ cfs

$6086 \leq 3.5 (66 - 0.4 \cdot 9.5) 9.5^{3/2}$
$6086 < 6374$ cf

Therefore, the PMF will be discharged with a reservoir level somewhat less than 519.5, less than the top of the parapet wall elev. of 520.

Check if flow down roads is supercritical
$n \sim 0.013$ (asphalt)
$s \sim 0.013$ (from USGS map)

$Q = 300$ cfs $\leq$ 500 cfs

$Q = a \frac{1.486}{n} \left(\frac{a}{w.p}\right)^{2/3} s^{1/2}$

if $d_n = 1$ ft $< d_c$
$300 \stackrel{?}{=} 25 \cdot \frac{1.486}{0.013} \left(\frac{25}{27}\right)^{2/3} 0.013^{1/2}$
~ 310 $\therefore$ flow supercritical

if $d_n = 1.4 < d_c$
$500 \stackrel{?}{=} 25 \cdot 1.4 \frac{1.486}{0.013} \left(\frac{25 \cdot 1.4}{25 + 2(1.4)}\right)^{2/3} 0.013^{1/2}$
$500 \sim 530$ cfs
$\therefore$ flow supercritical

Downstream Conditions

About 400 ft. below the dam is a culvert 7.5 ft. high & 19 ft. wide. Elevation of low point of embankment is 490 ±, about 20½ ft above the top of the culvert.

Flow thru culvert computed by orfice flow equation

$Q = CA\sqrt{2g\Delta H}$ Ref. National Engineering Handbook, Section 4 Eq. 14-25

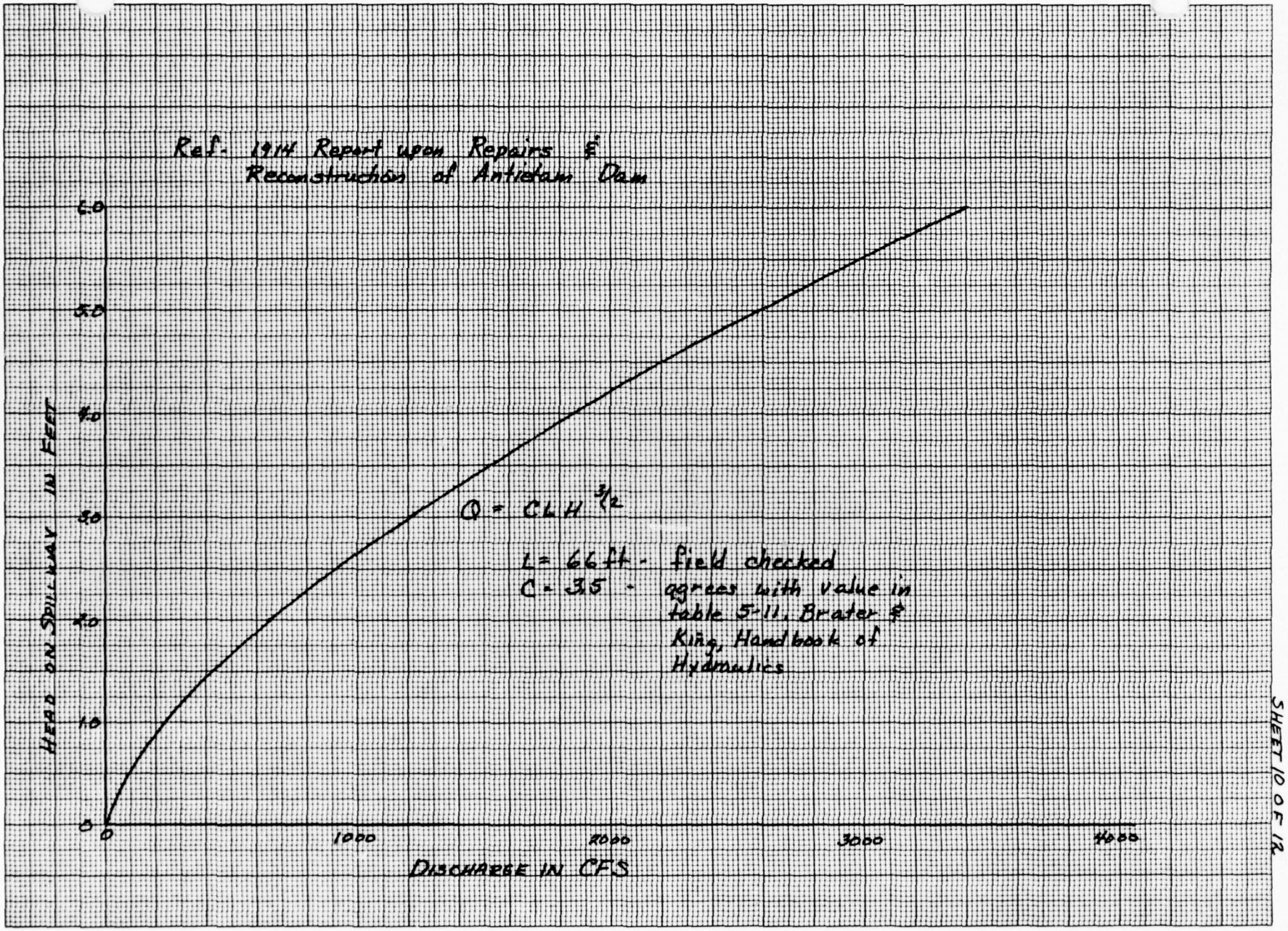
where Δh is the difference in water elevation upstream and downstream of bridge. – assume $\Delta h = 20.5$ ft

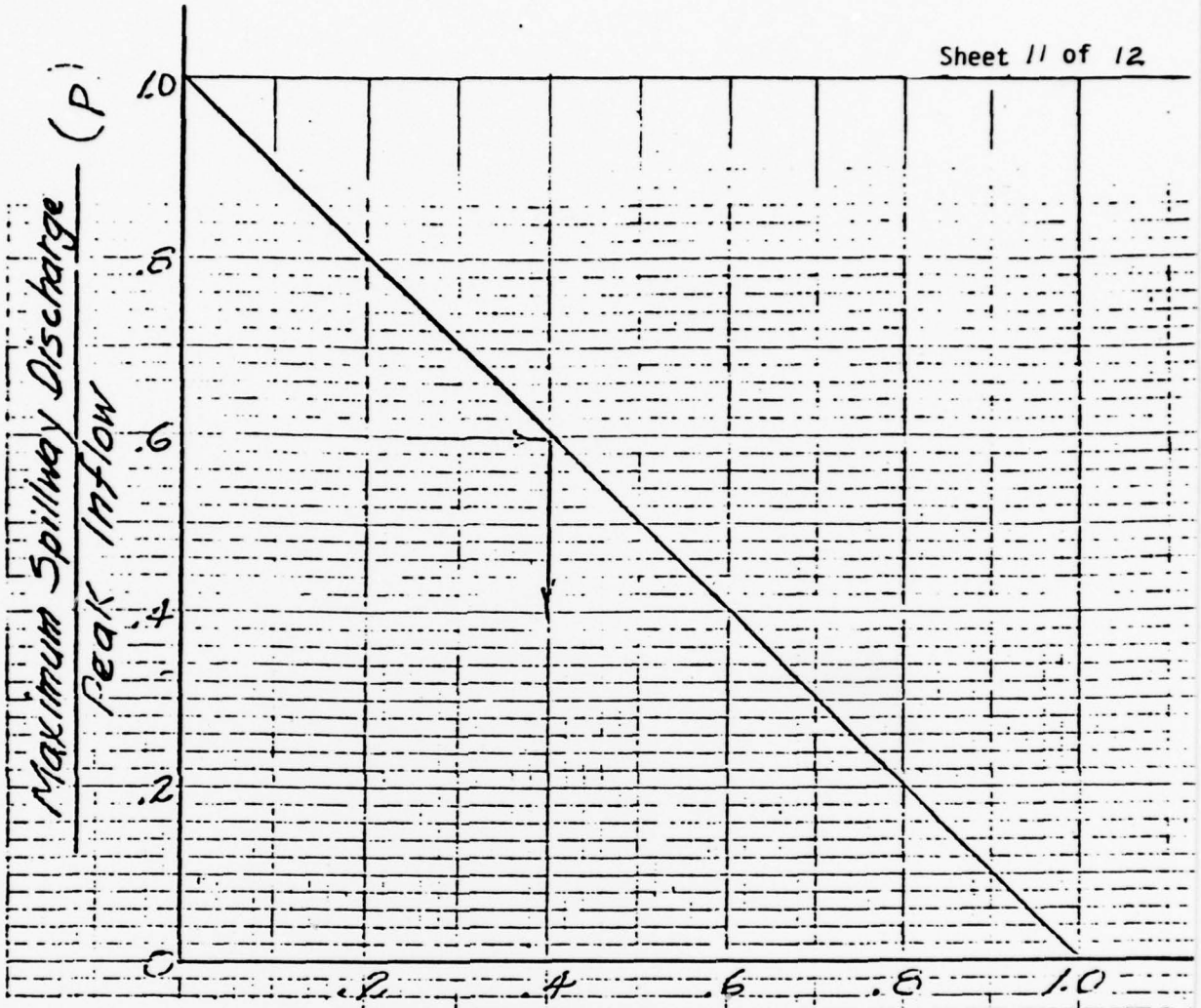
C ranges from 0.7 to 0.9, use 0.8 (p 14-45)
A = area under bridge

$Q = 0.8 \cdot 7.5 \cdot 19\sqrt{2g\,20.5}$

$= 4142$ cfs > spillway capacity

Ref. 1914 Report upon Repairs & Reconstruction of Antietam Dam

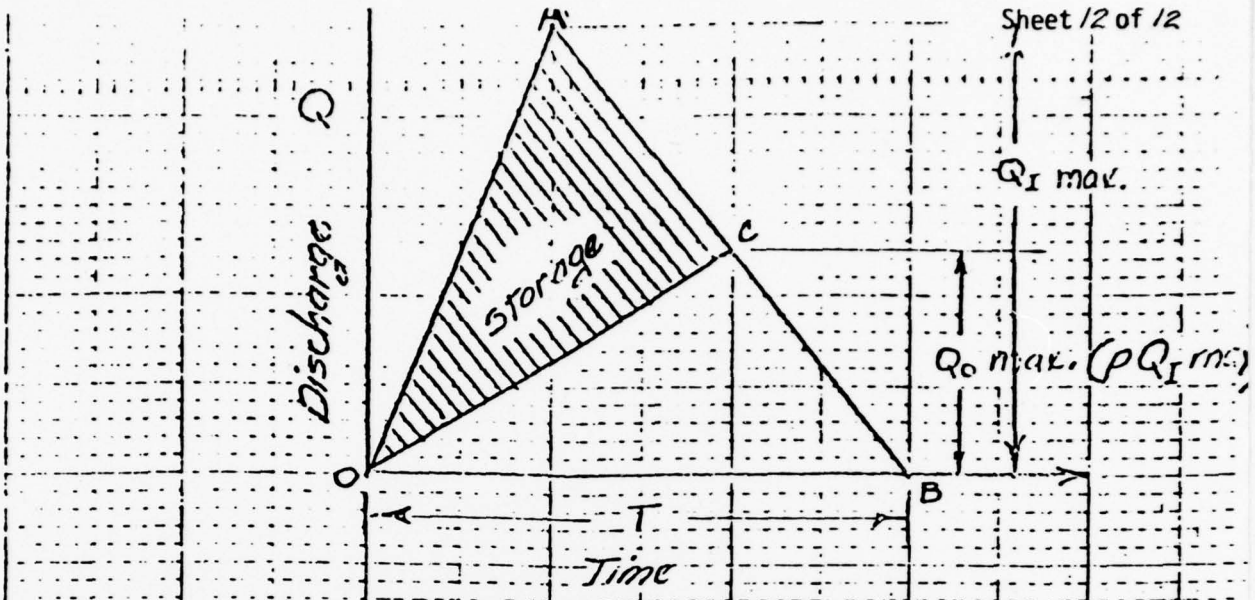




Steps to obtain required reservoir to pass inflo
hydrograph without overtopping dam.

1. Obtain maximum spillway discharge
2. Develop inflow hydrograph
3. Compute relationship of maximum spillway capacity to peak inflow
4. Read relationship of required reservoir storag to volume of inflow hydrograph from curve

page 12 of



PURPOSE: Establish relationship between maximum spillway discharge and storage required to pass flood hydrograph without exceeding maximum pool level.

$$\frac{\Delta AOC}{\Delta AOB} = \frac{\Delta AOB - \Delta COB}{\Delta AOB} = 1 - \frac{\Delta COB}{\Delta AOB}$$

$$\frac{\Delta AOC}{\Delta AOB} = 1 - \frac{T\,\rho Q_I \text{ max}/2}{T\,Q_I \text{ max}/2} = 1 - \rho$$

$$\Delta AOC = (1-\rho)\,\Delta AOB \quad \text{where } 0 \le \rho \le 1.0$$

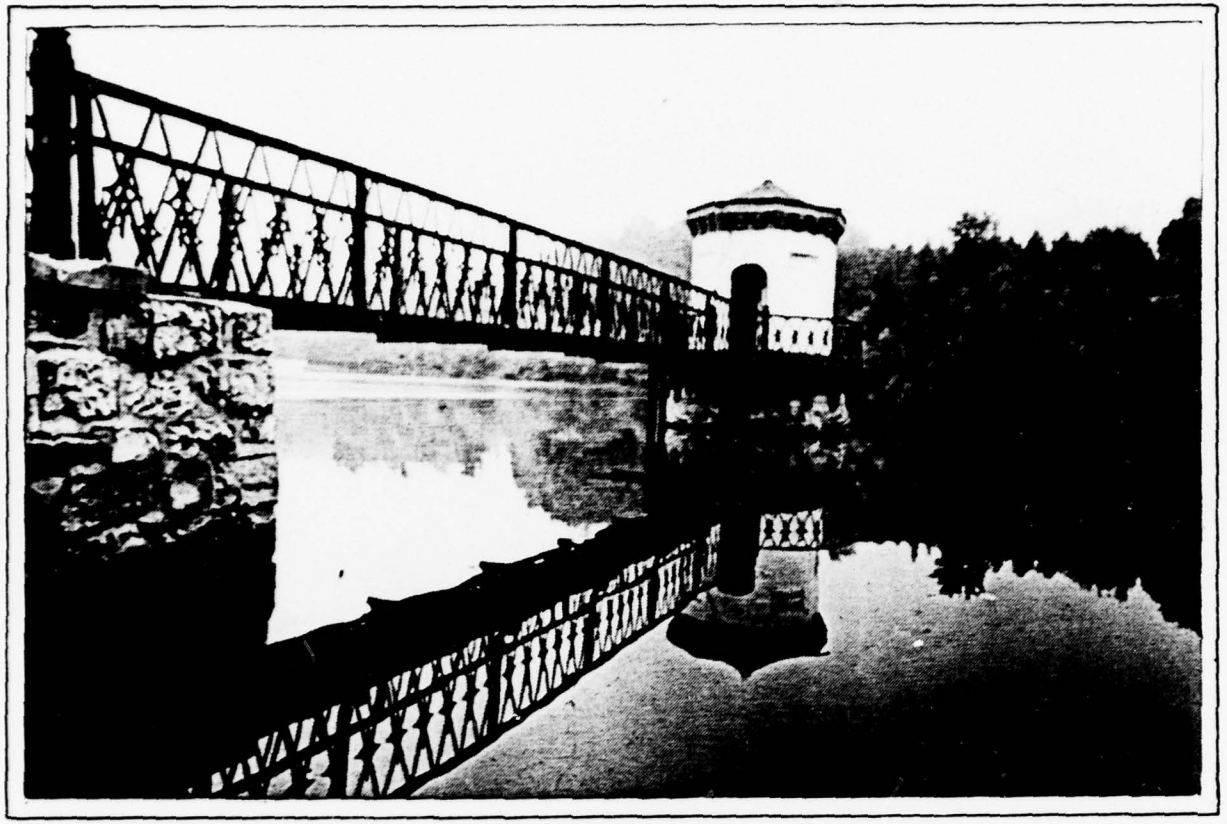
ρ	ΔAOC
1.00	0
0.75	0.25 ΔAOB
0.50	0.50 ΔAOB
0.25	0.75 ΔAOB
0	1.00 ΔAOB

REFERENCE

PRELIMINARY ENGINEER TECHNICAL LETTER NO. 1110-2- 25 January 1978

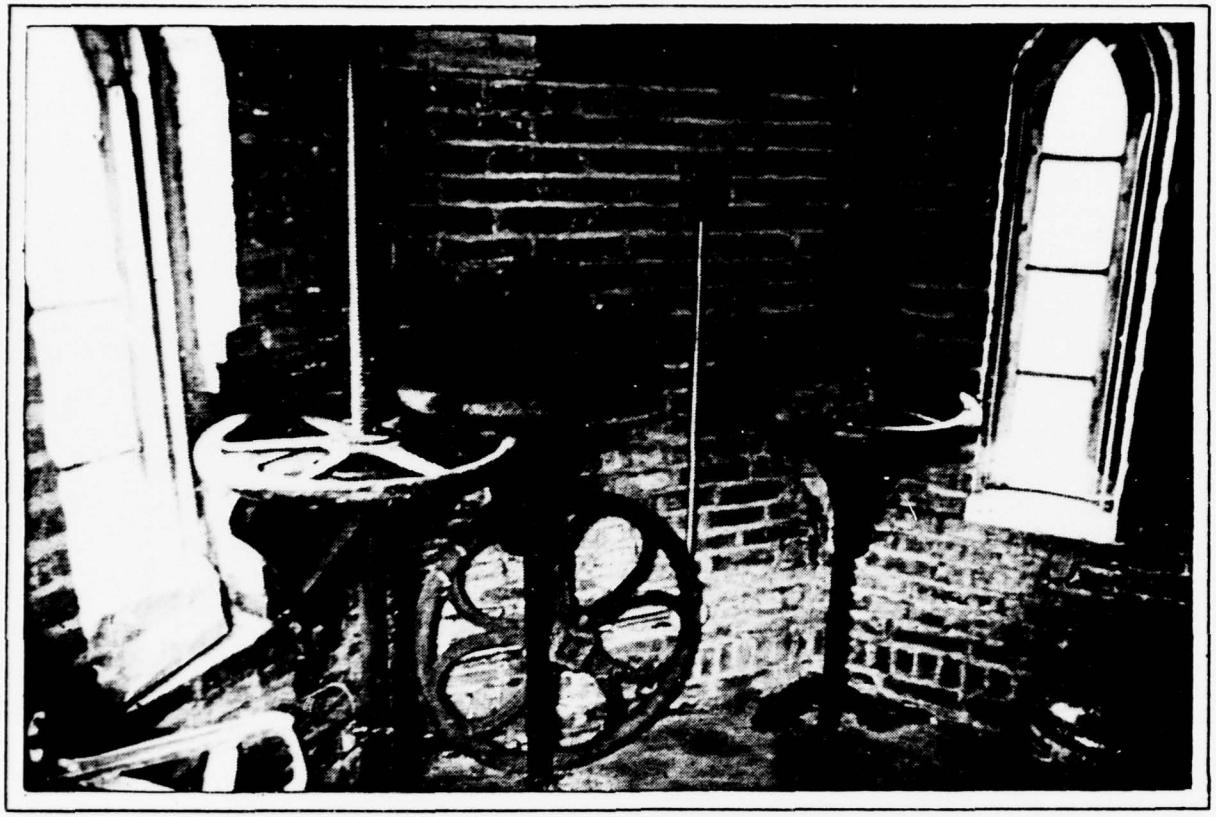
APPENDIX

D



OVERVIEW OF ACCESS BRIDGE AND WATER
SUPPLY CONTROL TOWER.

PHOTOGRAPH NO. 1

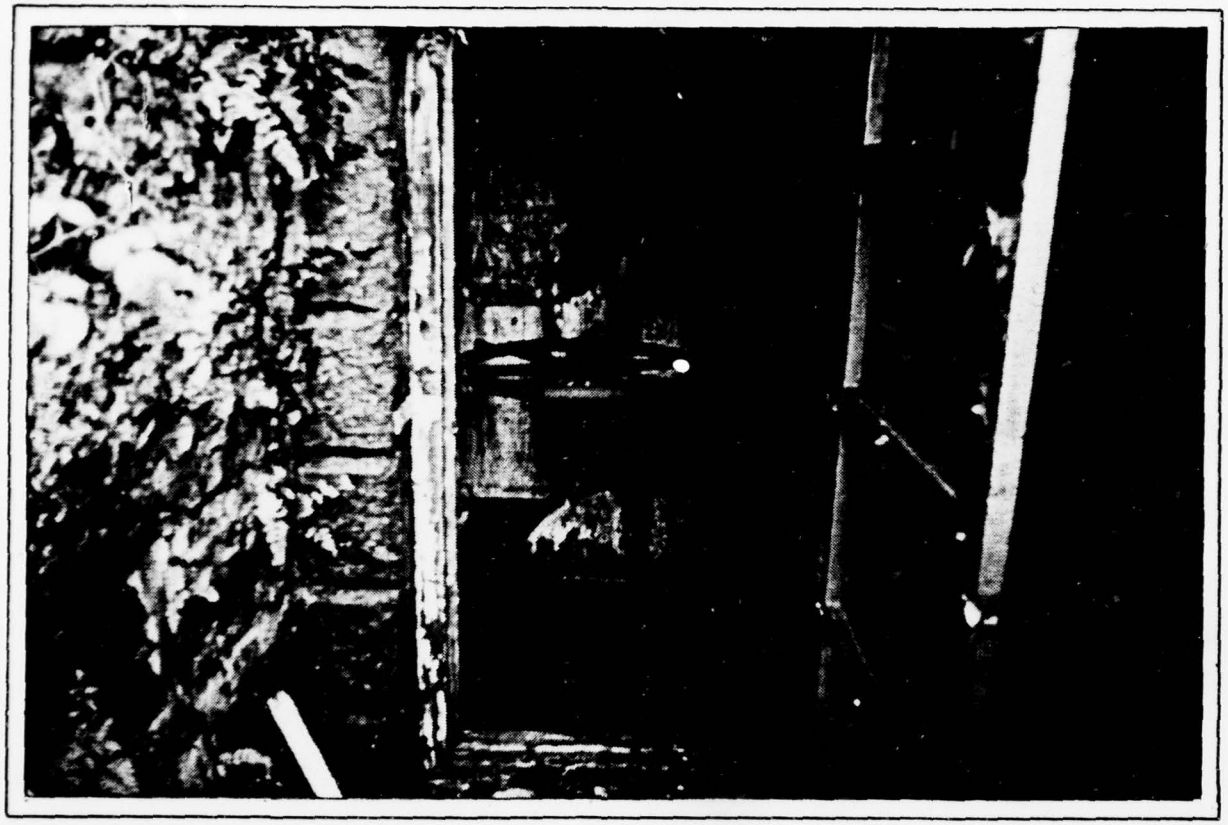


VIEW INSIDE CONTROL TOWER. GATE
VALVES ARE NON FUNCTIONAL.

PHOTOGRAPH NO. 2

VIEW OF THREE GATE VALVES INSTALLED ABOUT 1914. THEIR PURPOSE IS UNKNOWN.

PHOTOGRAPH NO. 3

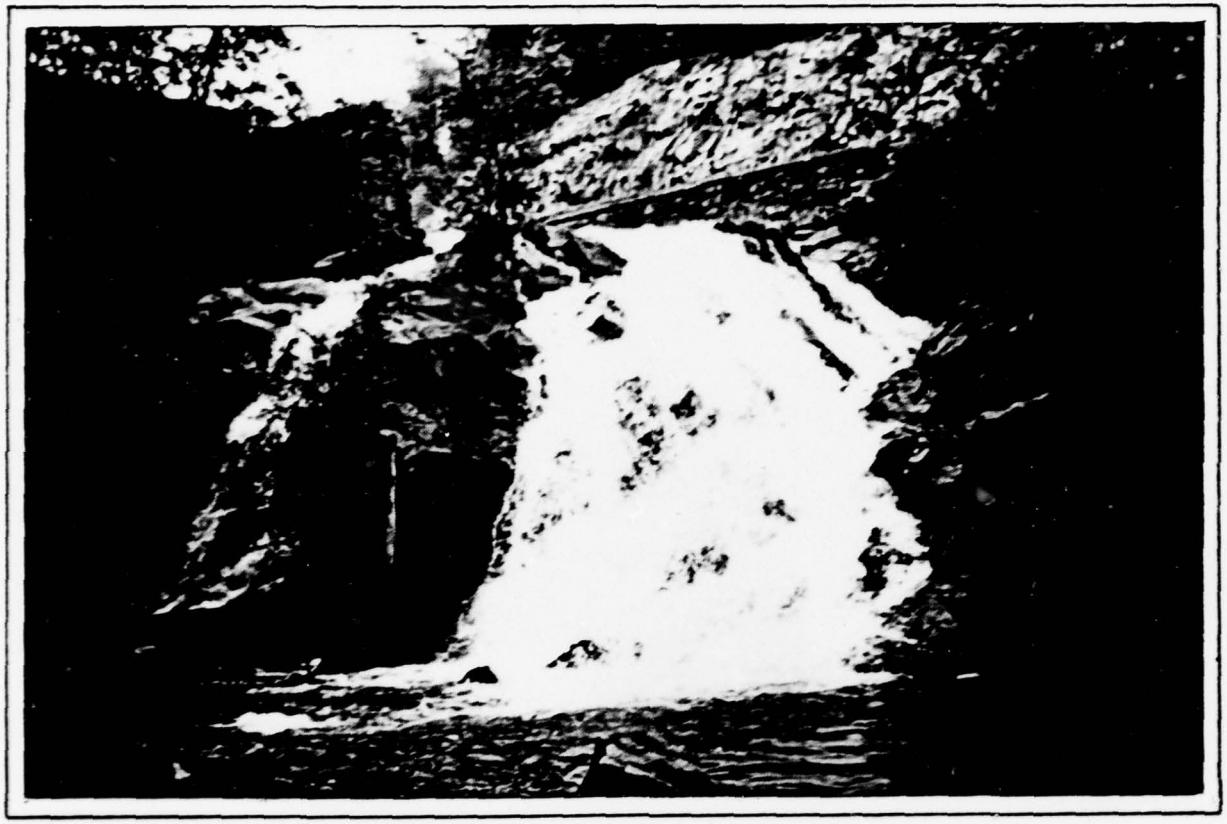


VIEW OF GATE HOUSE AND POND DRAIN VALVE.

PHOTOGRAPH NO. 4

VIEW OF SPILLWAY LOOKING UPSTREAM.

PHOTOGRAPH NO. 5

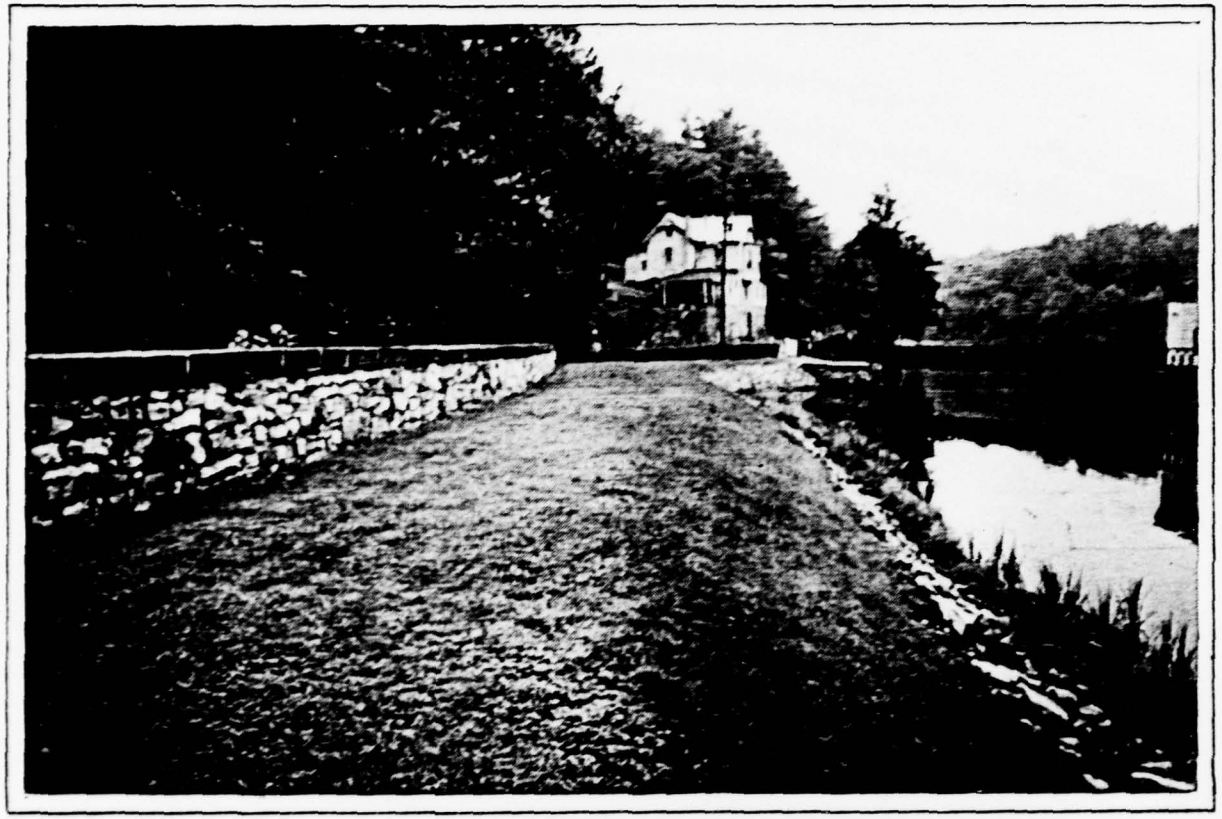


VIEW OF THE SPILLWAY DISCHARGE CHANNEL AS IT ENTERS THE NATURAL STREAM CHANNEL.

PHOTOGRAPH NO. 6

OVERVIEW OF NATURAL STREAM CHANNEL
LOOKING UPSTREAM.

PHOTOGRAPH NO. 7



OVERVIEW OF DAM LOOKING FROM SPILLWAY
TOWARDS RIGHT ABUTMENT.

PHOTOGRAPH NO. 8

VIEW OF DOWNSTREAM SLOPE OF DAM.

PHOTOGRAPH NO. 9

VIEW OF DOWNSTREAM SLOPE. NOTE VEGETATION AND OVERALL WET CONDITION OF MORTAR WALL.

PHOTOGRAPH NO. 10

VIEW FROM JUST BELOW DAM TOE LOOKING
DOWNSTREAM TOWARDS FIRST CULVERT
BELOW DAM.

PHOTOGRAPH NO. 11

FIRST HOUSE DOWNSTREAM OF THE DAM
JUST BEYOND THE CULVERT SHOWN IN
PHOTOGRAPH NO. 11.

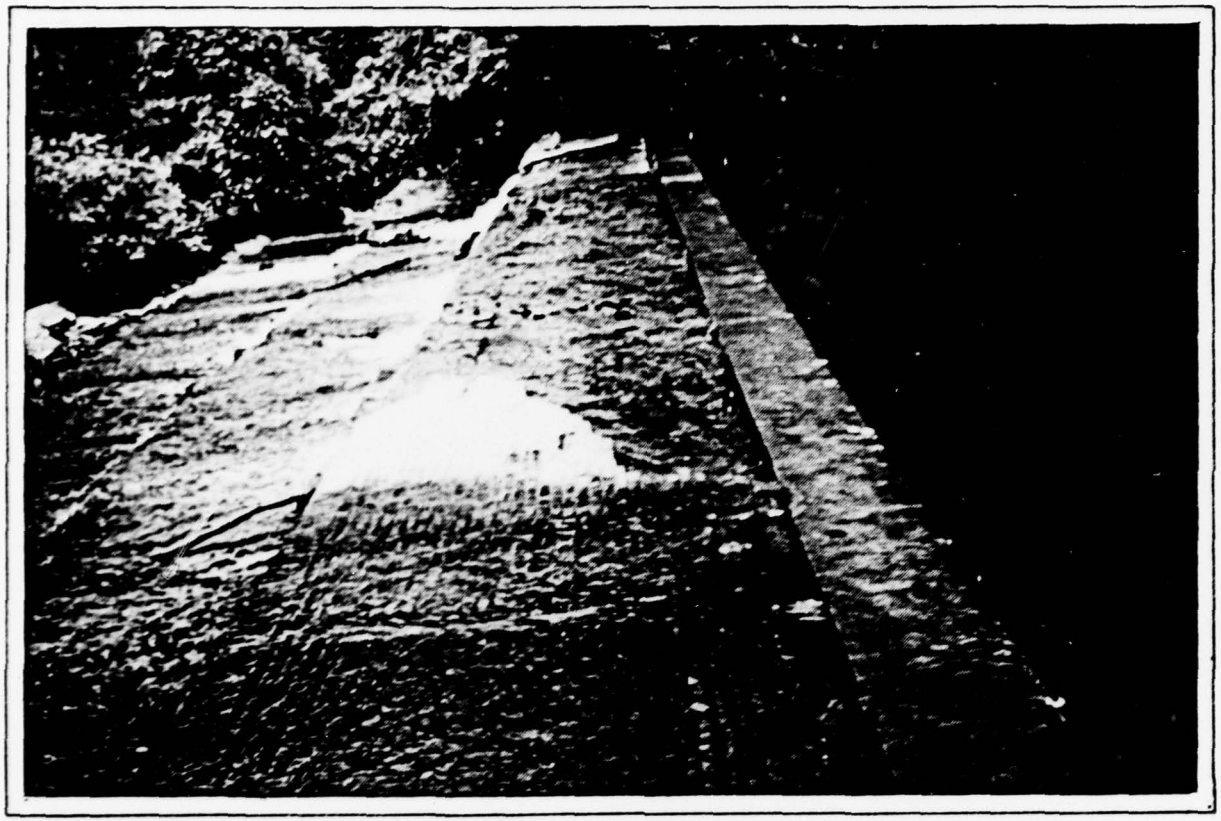
PHOTOGRAPH NO. 12

SMALL SCARP NOTED IN UPSTREAM SLOPE. THE SAME SCARP WAS NOTED IN A PHOTOGRAPH TAKEN IN 1970.

PHOTOGRAPH NO. 13

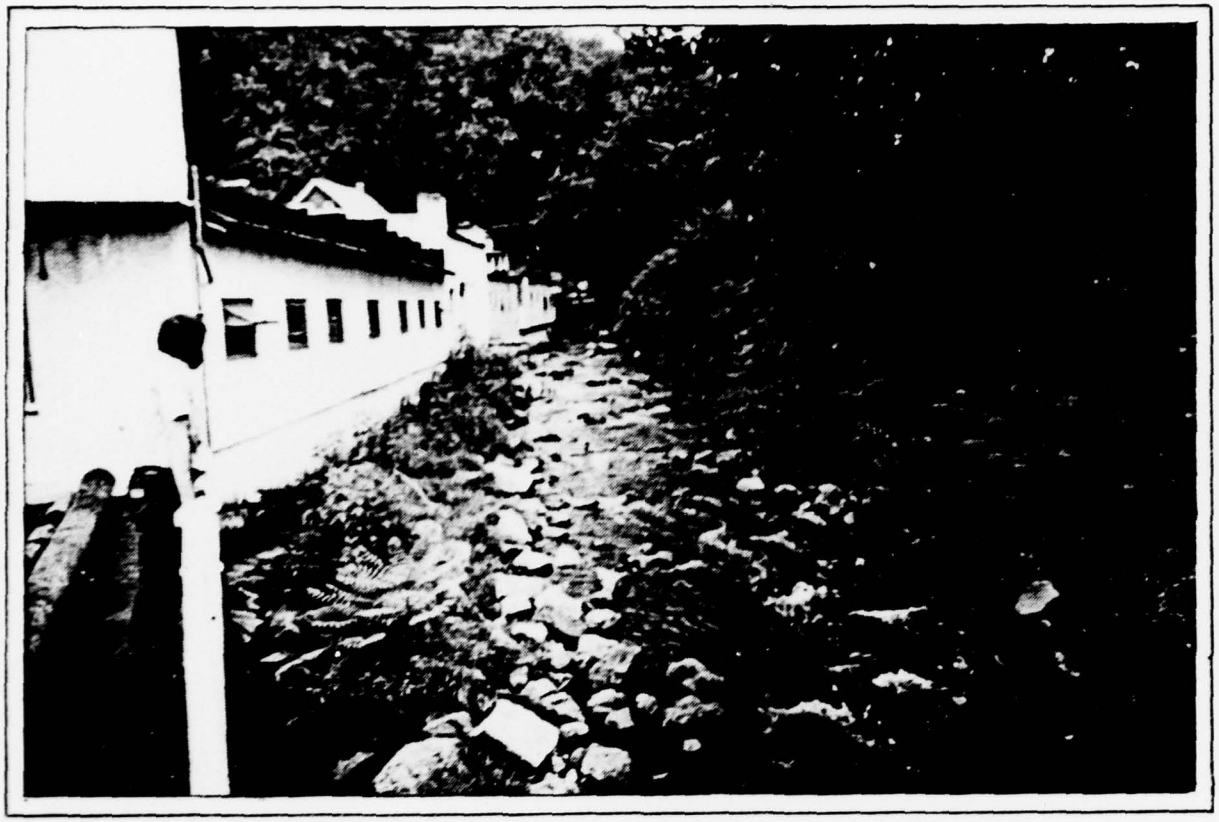
FIRST DAM UPSTREAM OF RESERVOIR
INSTALLED TO TRAP SEDIMENT.

PHOTOGRAPH NO. 14



SECOND DAM UPSTREAM OF RESERVOIR
INSTALLED TO TRAP SEDIMENT.

PHOTOGRAPH NO. 15

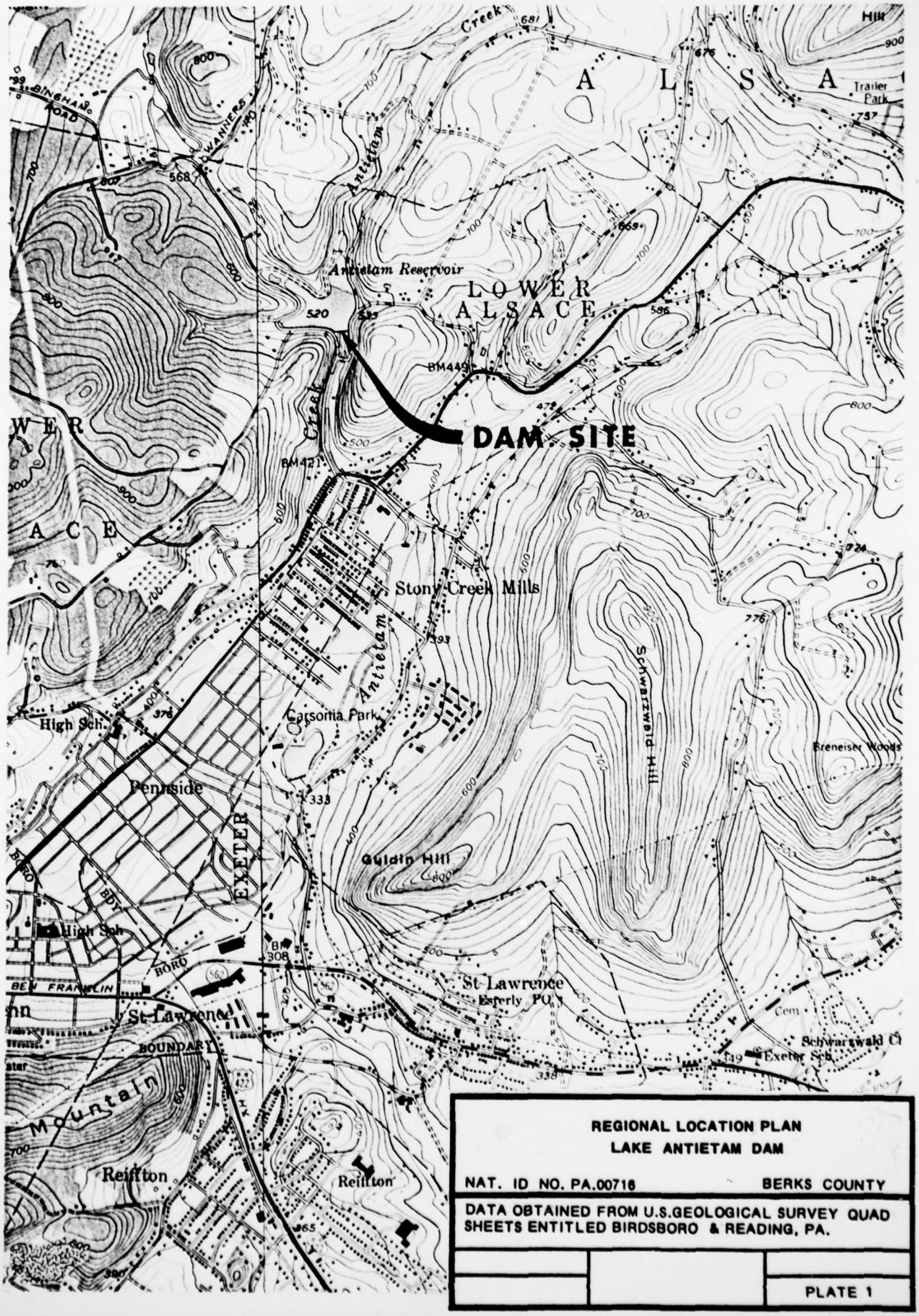


VIEW LOOKING UPSTREAM AS CREEK ENTERS THE TOWN OF STONY CREEK MILLS.

PHOTOGRAPH NO. 16

APPENDIX

E

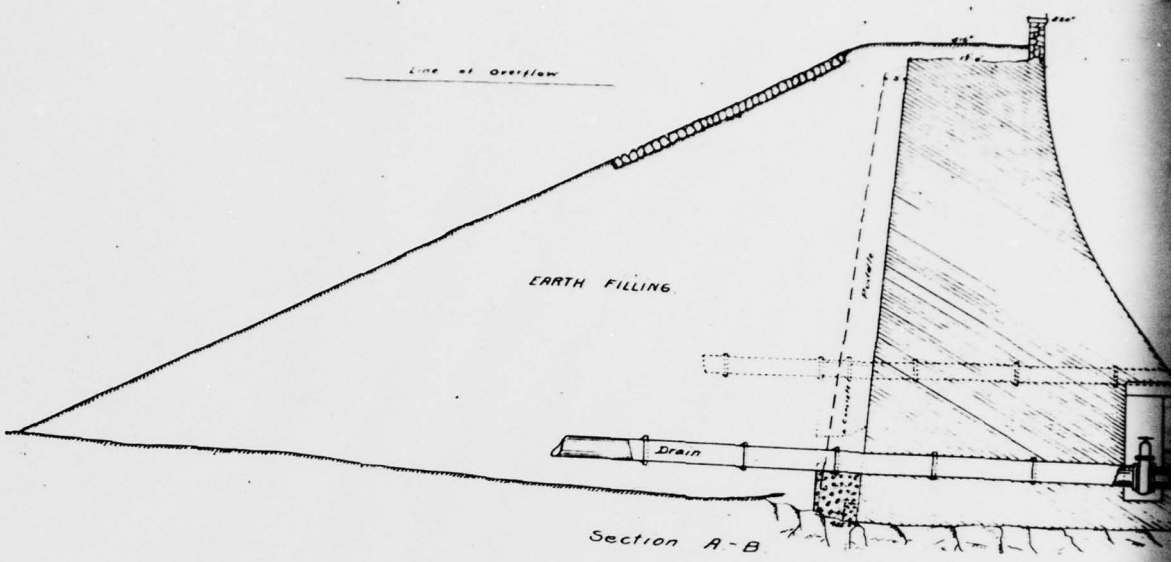


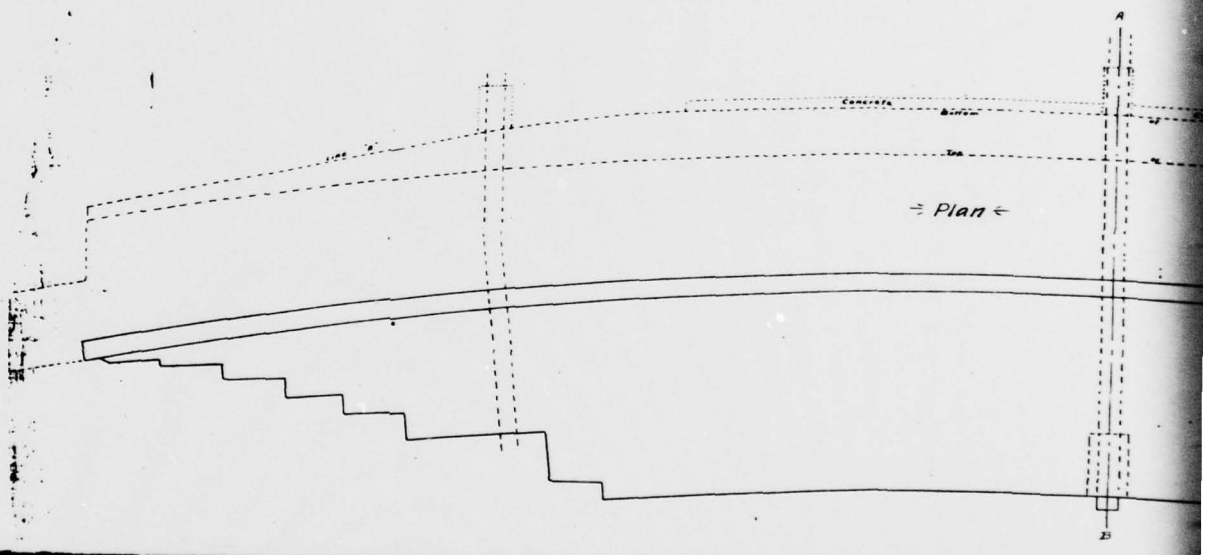
REGIONAL LOCATION PLAN
LAKE ANTIETAM DAM

NAT. ID NO. PA.00716 — BERKS COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEETS ENTITLED BIRDSBORO & READING, PA.

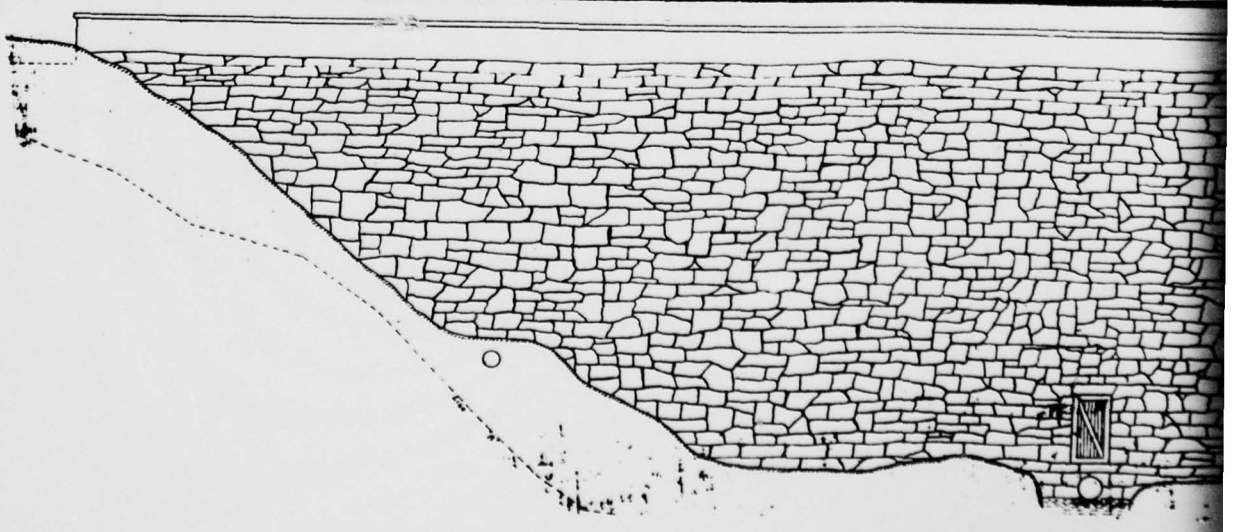
PLATE 1

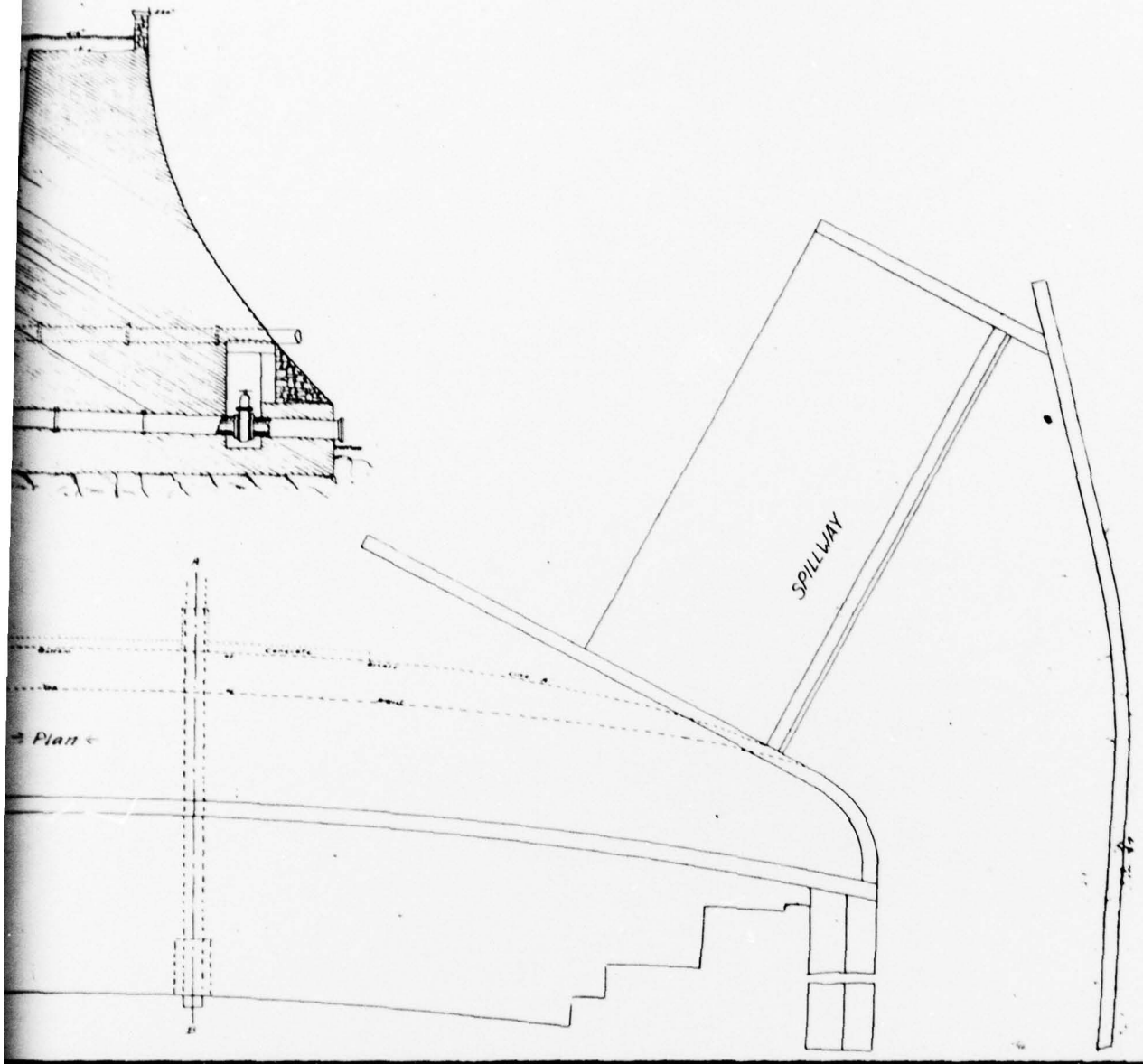




PLAN

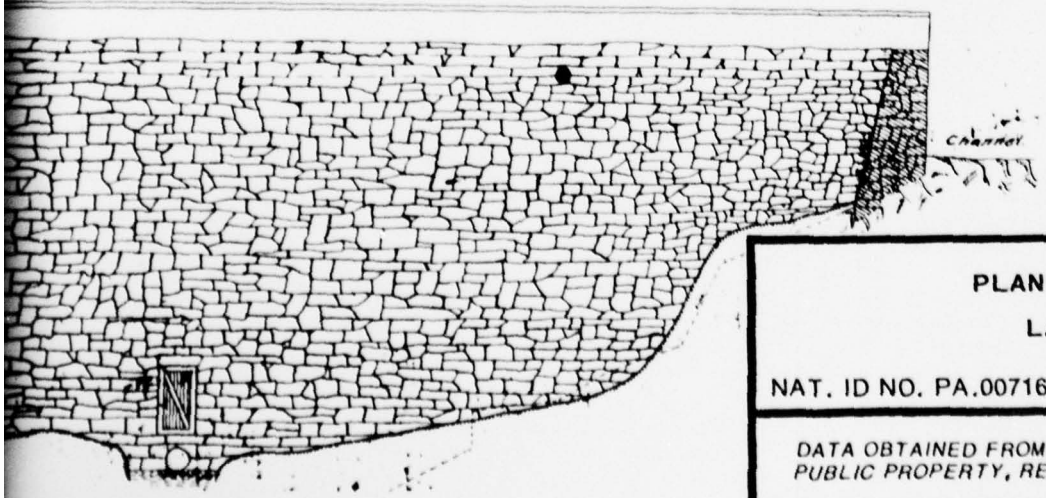
PROFILE





PLAN

PROFILE



2

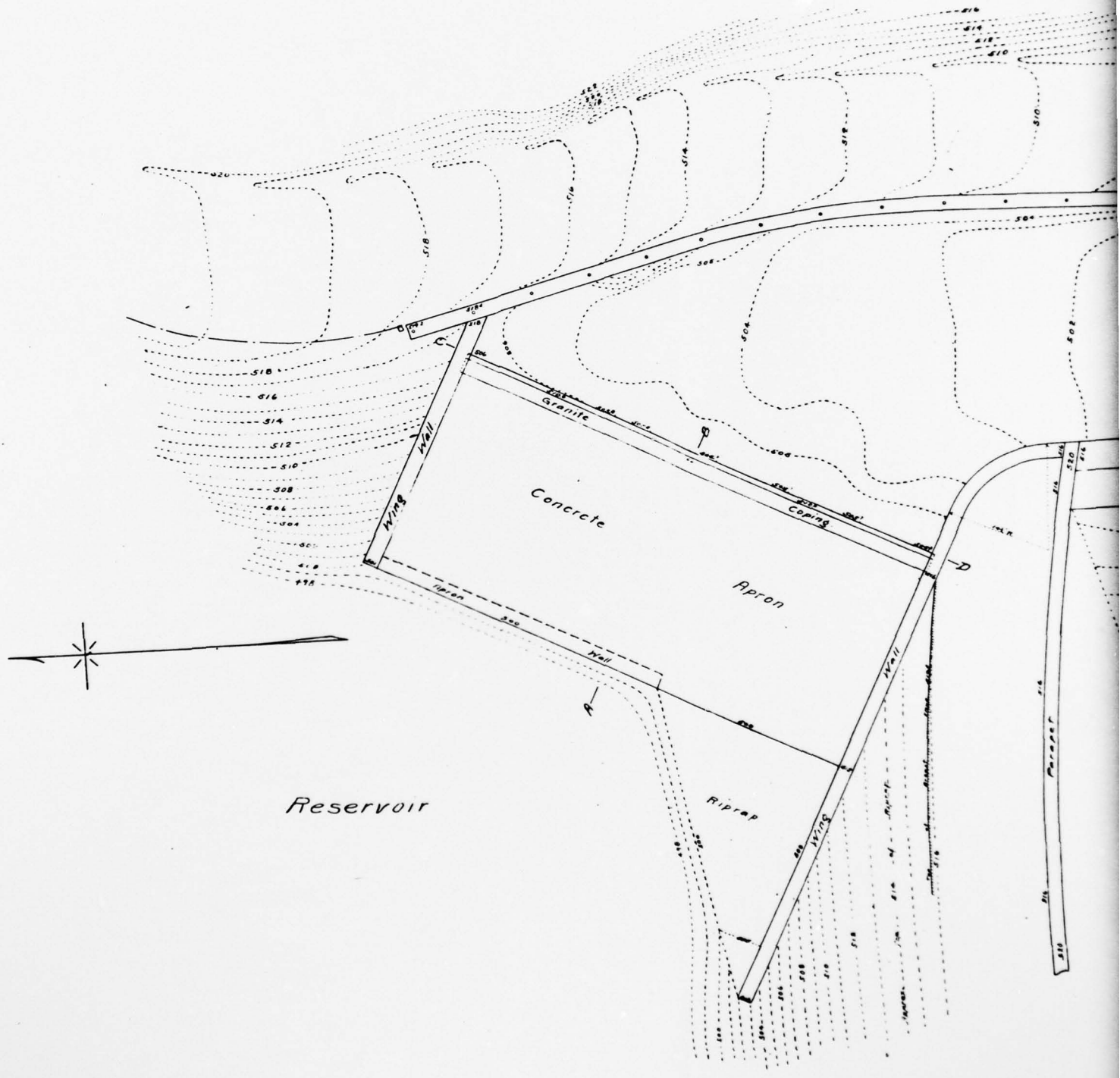
PLAN AND PROFILE OF DAM

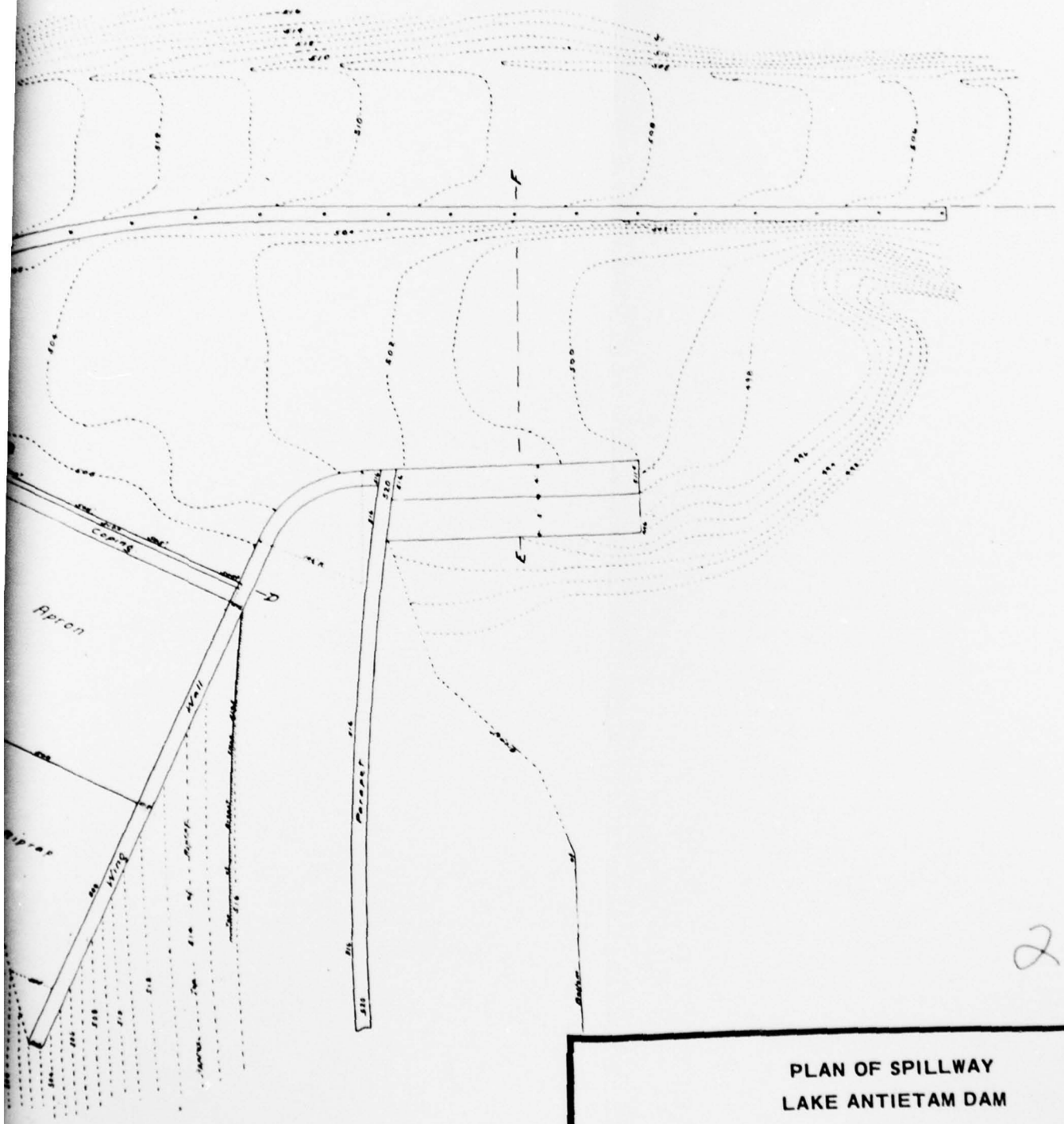
LAKE ANTIETAM DAM

NAT. ID NO. PA.00716 BERKS COUNTY

DATA OBTAINED FROM BUREAU OF WATER, DEPT. OF PARKS AND PUBLIC PROPERTY, READING, PA. SHEET NO. 1 , DATED JAN. 1915

PLATE 2


Granite Coping
Concrete Apron
Wing Wall
Wall
Riprap
Wing Wall
Riprap
Reservoir
A
B
C
D



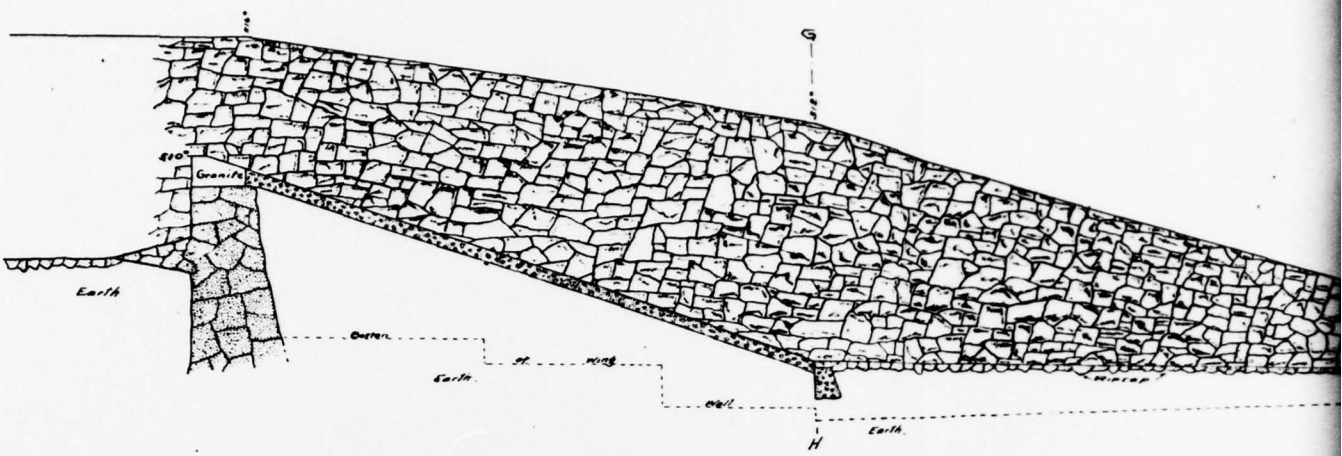
2

PLAN OF SPILLWAY
LAKE ANTIETAM DAM

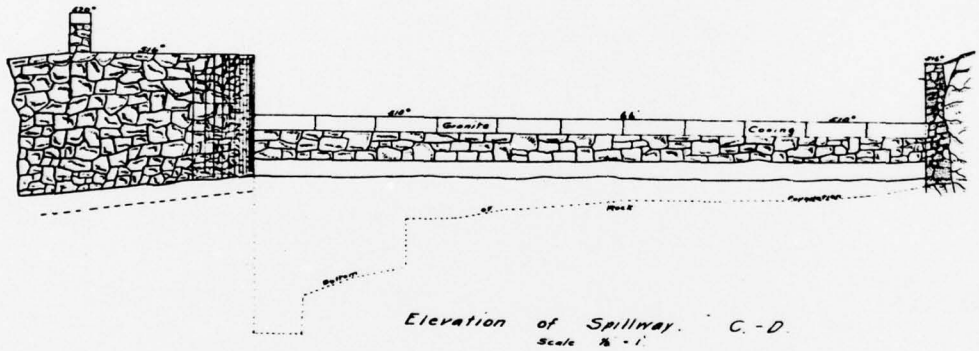
NAT. ID NO. PA.00716 BERKS COUNTY

DATA OBTAINED FROM BUREAU OF WATER, DEPT. OF PARKS AND PUBLIC PROPERTY, READING, PA. SHEET NO. 2 , DATED JAN. 1915

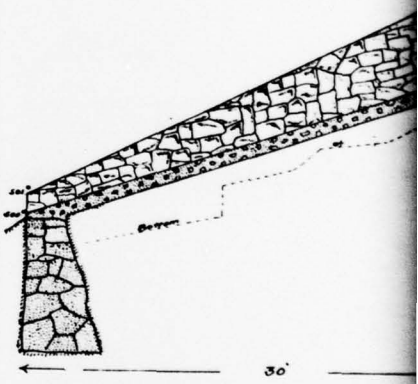
PLATE 3

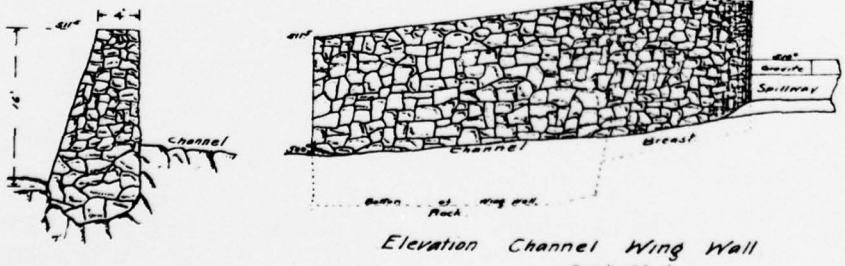


Elevation South Wing wall.
Scale ¼" - 1'

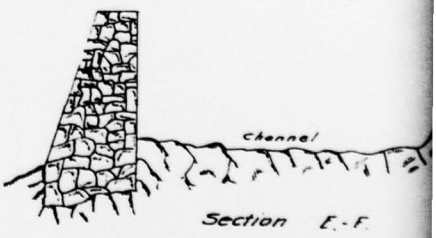


Elevation of Spillway. C. - D
Scale ⅛" - 1'

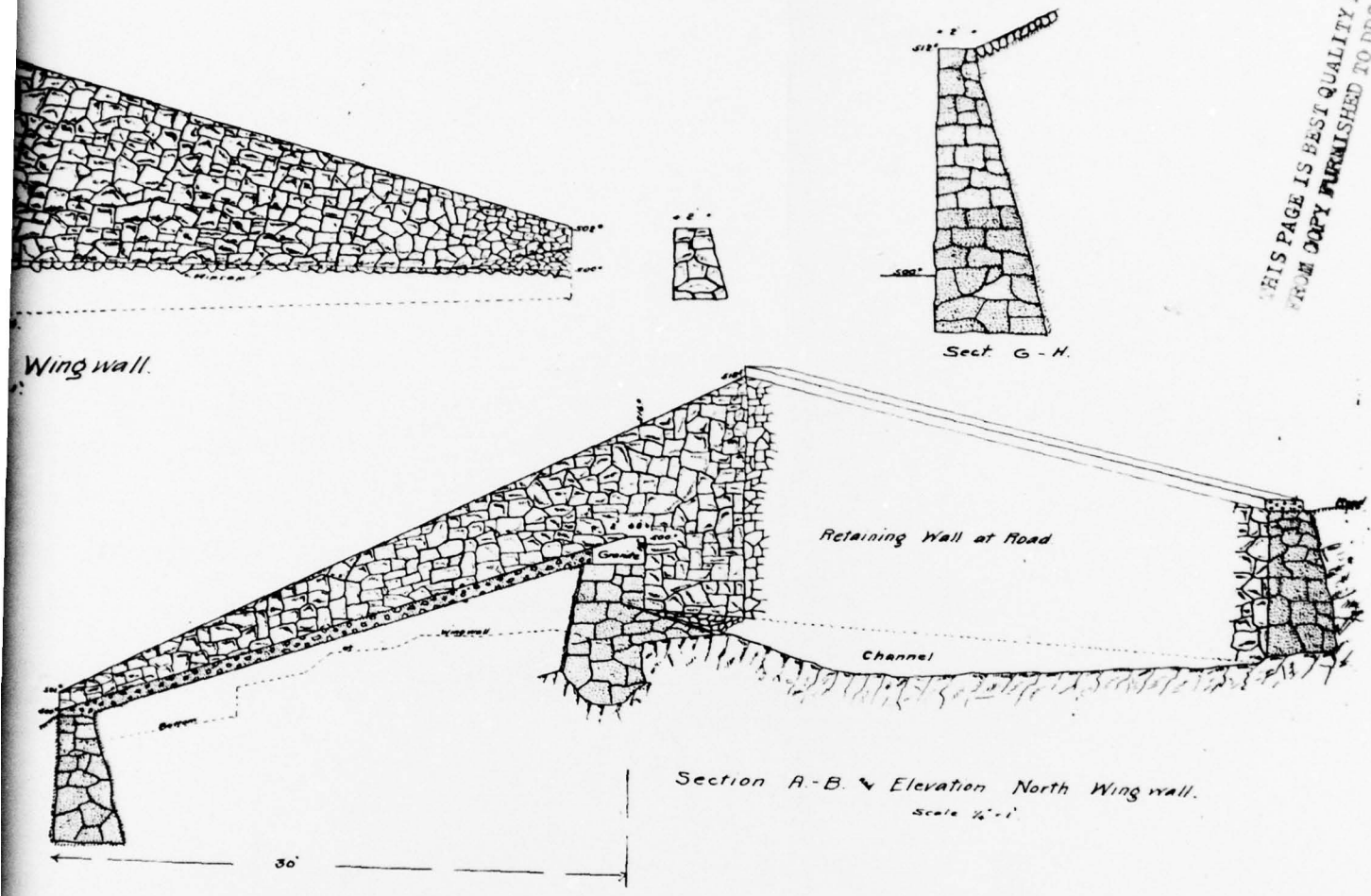


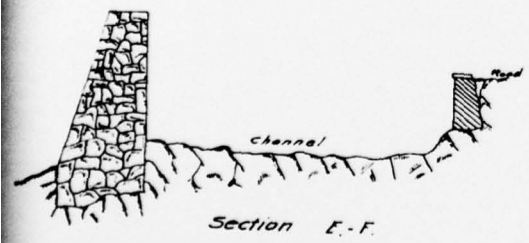


Elevation Channel Wing Wall
Scale ⅛" - 1'



Section E - F





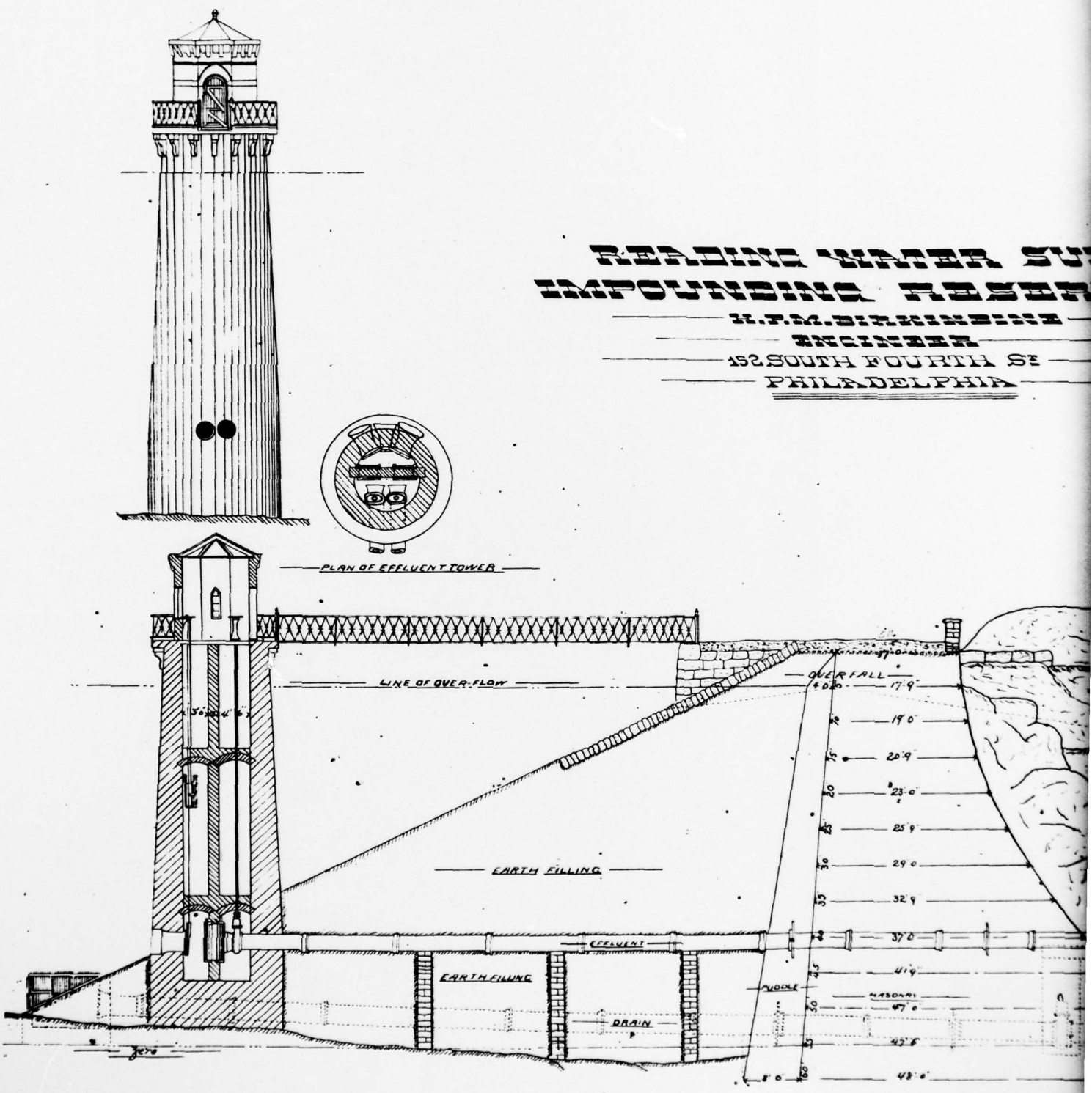
2

DETAILS OF SPILLWAY
LAKE ANTIETAM DAM

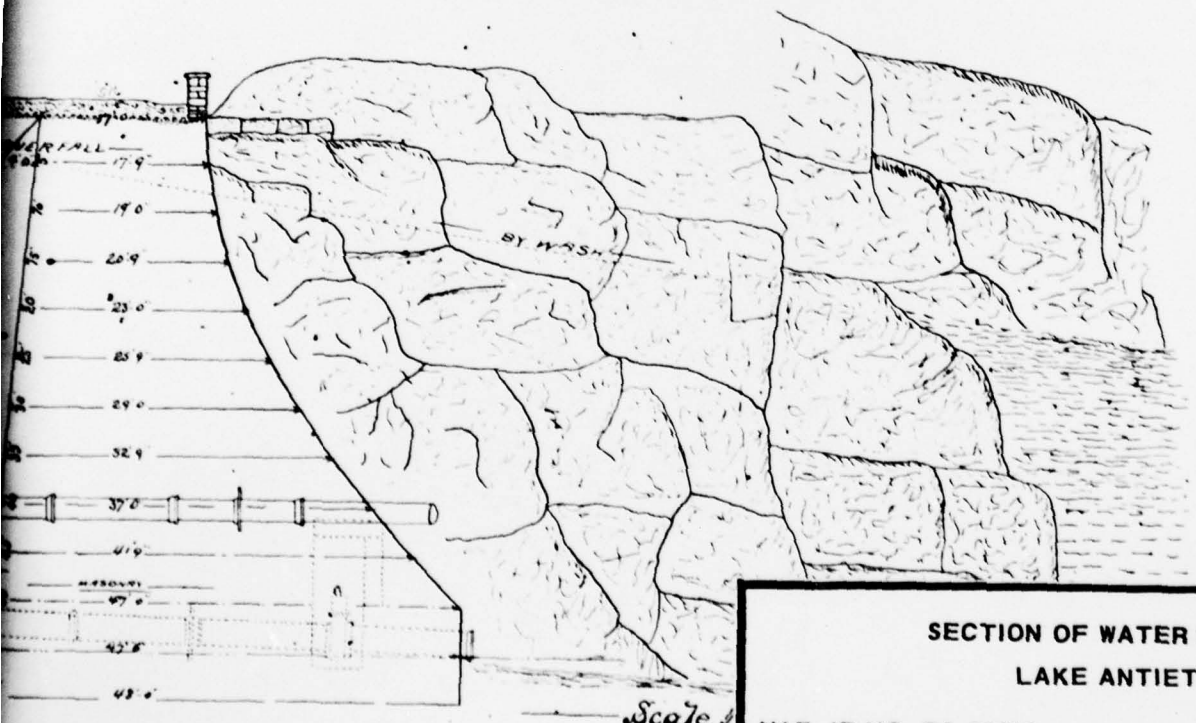
NAT. ID NO. PA.00716 — BERKS COUNTY

DATA OBTAINED FROM BUREAU OF WATER, DEPT. OF PARKS AND PUBLIC PROPERTY, READING, PA. SHEET NO. 3 , DATED JAN. 1915

PLATE 4


READING WATER SU
IMPOUNDING RESER
H.F.M. DIRKINSING
ENGINEER
152 SOUTH FOURTH St
PHILADELPHIA
PLAN OF EFFLUENT TOWER
LINE OF OVER-FLOW
OVERFALL
EARTH FILLING
EFFLUENT
EARTH FILLING
DRAIN
MUDDLE
MASONRY
17·9
19·0
20·9
23·0
25·8
29·0
32·9
37·0
41·9
47·0
45·6
48·0

WATER SUPPLY
RS RESERVOIR
H.P.M.BIRKINBINE
ENGINEER
142 SOUTH FOURTH ST
PHILADELPHIA



8

SECTION OF WATER SUPPLY TOWER
LAKE ANTIETAM DAM

NAT. ID NO. PA.00716 BERKS COUNTY

DATA OBTAINED FROM H.P.M.BIRKINBINE, ENGINEER
142 SOUTH FOURTH ST. PHILA.,PA. DATED OCT.1879

PLATE 5

APPENDIX

F

SITE GEOLOGY
LAKE ANTIETAM DAM

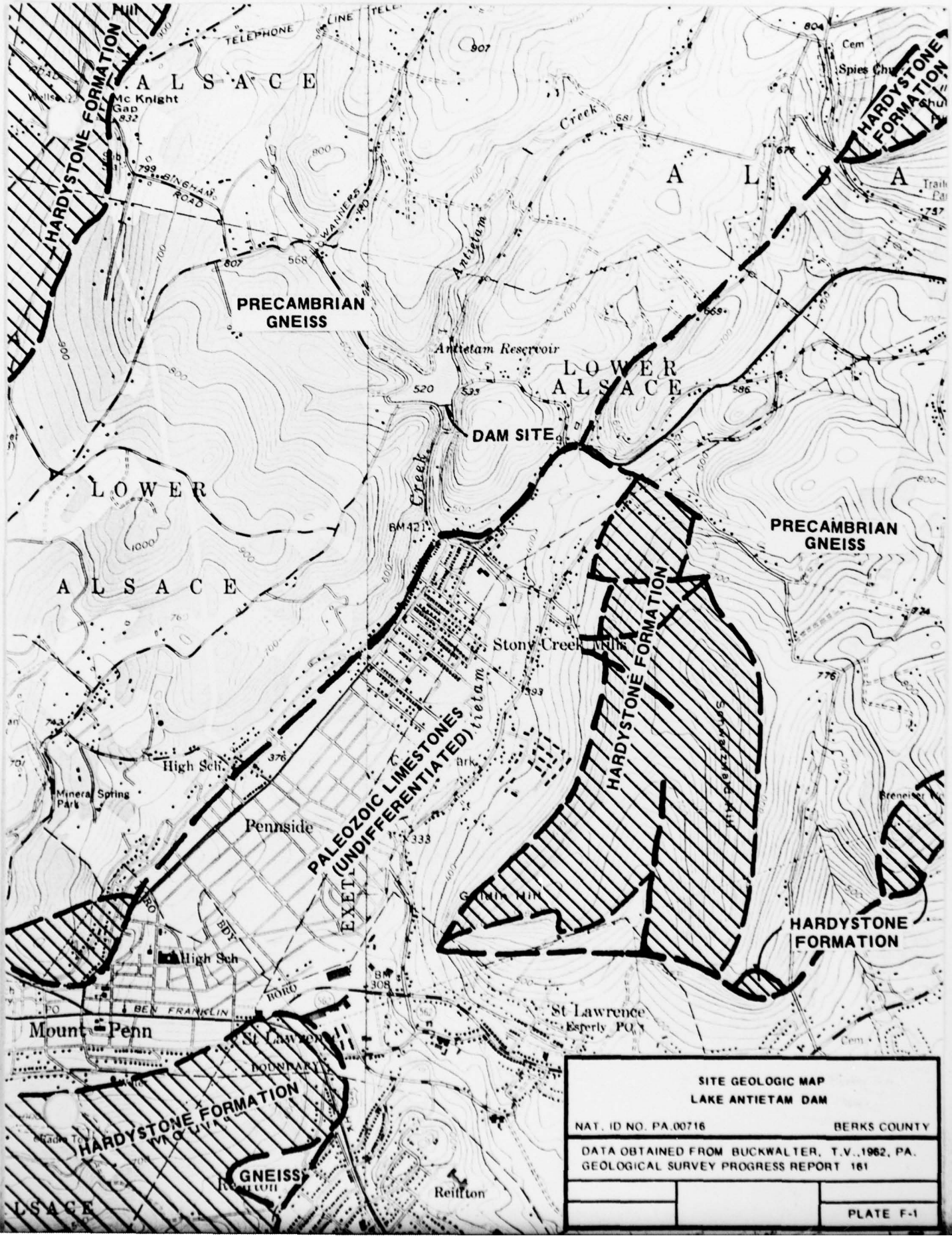
The Lake Antietam Dam is located at the southeast edge of the Reading Prong section of the New England Physiographic Province. The bedrock at the dam site consists of the Precambrian gneisses of the Reading Prong (see Plate F-1). These rocks are bounded to the northeast and to the south by the limestones and quartzites of the Cambrian Elbrook, Conococheaque, and Hardyston Formations. In the site area, the Precambrian gneisses are cut by a foliation striking to the northeast and dipping steeply to the southeast (Buckwalter, 1962).

Precambrian gneisses of the Reading Prong are reported to be highly variable and irregular as far as spacing and orientation are concerned. Rock jointing is well developed in the dam site area resulting in a blocky form to the bedrock exposures. There is both a northeast and northwest striking set of joints which cross obliquely to the dam axis. Although fractured gneiss is expected to be a good producer of groundwater, only a few joints are favorably oriented for downstream seepage.

A number of lower Paleozoic faults have been reported in the area, with the longest being over five miles, striking to the northeast and passing just south of the dam.

References:

1. *Buckwalter, T.C., 1962, Precambrian Geology of the Reading 15' Quadrangle: Pennsylvania Geological Survey, 4th Series, Progress Report 161, 1:24,000.*


HARDYSTONE FORMATION
ALSACE
Mc Knight Gap
TELEPHONE LINE
BINGHAM ROAD
WARNER RD
Antietam Creek
PRECAMBRIAN GNEISS
Antietam Reservoir
LOWER ALSACE
DAM SITE
Stony Creek
PALEOZOIC LIMESTONES (UNDIFFERENTIATED)
Antietam
HARDYSTONE FORMATION
Spies Church
High Sch.
Mineral Spring Park
Pennside
High Sch
BEN FRANKLIN
Mount Penn
St Lawrence
Esperly PO
BOUNDARY
HARDYSTONE FORMATION
GNEISS
Reiffton
SITE GEOLOGIC MAP
LAKE ANTIETAM DAM
NAT. ID NO. PA.00716
BERKS COUNTY
DATA OBTAINED FROM BUCKWALTER, T.V., 1982, PA. GEOLOGICAL SURVEY PROGRESS REPORT 161
PLATE F-1